OIL SHALE TRACT C-b

REVISED DETAILED DEVELOPMENT PLAN

VOLUME I PROJECT DESCRIPTION

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OIL SHALE TRACT C-b

REVISED DETAILED DEVELOPMENT PLAN

VOLUME II DEVELOPMENT MONITORING PROGRAM

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1.0 INTRODUCTION AND SUMMARY

1.1 General Introduction and Historical Perspective

The Cathedral Bluffs oil shale project is a joint venture of Occidental Oil Shale Inc. (operating partner) and Tenneco Shale Oil Company (partner) on lease tract C-b, a 5,000-acre section of federally-owned land located in the Piceance Creek Basin in northwestern Colorado.

The tract was first leased early in 1974 to Atlantic Richfield, Ashland Oil, Shell Oil, and Tosco by BLM under the newly established Federal Prototype Oil Shale Leasing Program. As stated by the Secretary of the Interior, the objectives of the prototype program are:

° To provide a new source of energy that will increase the range of energy options available to the nation by stimulating the timely development of commercial oil shale technology by private industry;

° To ensure the environmental integrity of the affect areas, and concurrently define, describe and develop a full range of environmental safeguards and restoration techniques that can be reasonably incorporated into the planning for a possible mature oil shale industry in the future;

° To permit an equitable return to all parties in the development of this public resource; and

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1.1 General Introduction and Historical Perspective

- To develope management expertise in the leasing and supervision of oil shale resource development in order to provide the basis for future administrative procedures.

To ensure compliance with these objectives and to administer the leasing program, the Oil Shale Office (OSO) was established.

Early in 1976, following the withdrawal of Atlantic Richfield and Tosco from the venture, Ashland and Shell Oil Company submitted the first Detailed Development Plan to the OSO that outlined a conventional room-and-pillar method of mining with surface retorting of the mined shale. Only 68 to 77 feet of the richest oil shale strata in the Mahogany zone would be developed by the single-level, room-and-pillar mining system considered in the plan. Following a nine month review of the DDP, the lessee was notified that the development plan met the terms and conditions of the lease, however its implementation required resolution of technical issues which resulted in a 1-year suspension of operations effective September 1, 1976. By the end of that year, Shell withdrew from the project and Occidental Petroleum Corporation (Oxy) joined Ashland in the venture.

Oxy proposed using its Modified In Situ (MIS) method of oil shale mining which deviated from the plan described in the first DDP. The MIS process did, however, offer a possible solution to the technical problems which suspended operations.

1.0 INTRODUCTION AND SUMMARY

1.1 General Introduction and Historical Perspective

A modified Detailed Development Plan, submitted in February 1977, reflected the mining strategy change to the MIS process. During the six-month OSO review, Ashland and Oxy supplied information that responded to public, private, and government concerns. This material in combination with the original DDP were found to satisfy the oil shale lease and, with 12 conditions, were approved in August 1977.

In 1978, Ashland withdrew from the project and Tenneco Oil Company of Houston, Texas, (a division of Tenneco, Inc.) joined Oxy to form the Cathedral Bluffs Shale Oil Company in April, 1979. Late in 1977, construction of a commercial facility began in accordance with the plan approved by the OSO.

A revision to the DDP began in mid-1980 to address strategy and design changes resulting from increased overall understanding of the MIS process combined with a gassy mine classification issued by the Mine Safety and Health Administration. In addition to compiling applicable features described in past development proposals, this new document discusses significant changes in design, layout, and operation of the underground oil shale mine and its integral shale oil recovery system. The revised DDP presents complete, definitive plans for tract development, and is submitted to comply with all terms and conditions described in Oil Shale Lease C-20341.

1.0 INTRODUCTION AND SUMMARY

1.2 Organization

As a general guide, Volume I contains all construction plans, schedules, economic projections, environmental control proposals, and feasible development alternatives. Volume II addresses project monitoring. The following paragraphs summarize each section of Volume I. See the first section of Volume II for a summary of project monitoring.

Section 1 contains introductory material relating to the tract including historical developments, objectives of the Federal Prototype Oil Shale Leasing Program, and an executive summary of Volume I.

Section 2 highlights the geology, flora, meteorlogy, hydrology, soils, and fauna of Tract C-b. This section focuses on natural site characteristics.

Section 3 presents and describes the overall mine development schedule. Topics covered include schedules for engineering, construction, procurement, reclamation, surface disturbance, manpower, and off-tract development.

Section 4 is a detailed description of the mine development plan. Items discussed include equipment, materials, manpower, and procedures proposed to construct and operate a commercial-scale shale oil production facility on the tract.

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Section 5 describes the surface process facilities serving MIS retorts. Topics include shale oil/water separation, offgas scrubbing and compression, steam generation and power production, flue gas desulfurization, water management, byproduct recovery, storage and shipping, and miscellaneous utilities.

Section 6 discusses surface retorting of the oil shale removed during mine and MIS retort development. Methods of conveying, crushing, screening, and storage of raw shale are explained along with a description of the surface retorting products and its subsequent storage and shipment.

Section 7 discusses methods of handling both processed and raw shale. Topics covered include choosing disposal sites and stockpile areas, transferring shale, preparation and compaction of processed shale, and chemical and physical characteristics.

Section 8 describes the site access and service plan. Methods of transporting utilities, fuel, water, and supplies to the mine site are discussed as well as the shipment of product oil.

Section 9 explains the plan for environmental protection at the site. Topics include air, water, fire, noise, subsidence, aesthetic, safety, and erosion control plans.

Section 10 discusses overall environmental impact envisioned at the C-b Tract.

1.0 INTRODUCTION AND SUMMARY

1.2 Organization

Section 11 addresses realistically feasible alternatives for disposing processed shale, shipping products, distributing material, and retorting and upgrading oil shale.

Section 12 describes capital costs for mine support and in situ processing. Costs for surface retorting, off-tract development, and environmental controls are included.

Section 13 discusses steady state operating costs for the mine and its facilities, in addition to operating costs for environmental control and reclamation activities.

Section 14 discusses the socioeconomic elements of developing an oil shale project on Tract C-b.

1.3 Executive Summary

Tract C-b will be developed in accordance with a three-phase mining plan applying the Modified In Situ process to a 290-ft stratigraphic section located approximately 1,200 feet below the surface. Initial mine level development will commence following completion of the Production, Service, and Ventilation/Escape (V/E) shafts, which are currently under construction, but not scheduled to be fully operational until late in 1982. Construction of a process offgas shaft, a pair of mine air exhaust shafts, and a mine air intake shaft will proceed concurrently with initial level development to meet ventilation needs.

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1.3 Executive Summary

Oil shale removed during development of the tract's 1,805 in situ retorts will eventually be processed in surface retorting facilities. Partial production from these facilities will begin in 1985, but will not reach full capacity until 1990. Shale processed in these surface retorts will be stored on the site and eventually revegetated.

MIS operations will account for nearly 64 percent of the anticipated 1.05 billion barrels of shale oil recovered. The remaining 36 percent, or nearly 386 million barrels, will be derived from surface retorting.

The following sections will add detail to this basic development description. Topics discussed will cover the tract's natural characteristics (site description and resource potential), in addition to proposed development activities and environmental control procedures.

.1 Tract Description

Tract C-b is a 5,094-acre area of federal-owned land located in the oil shale-rich Piceance Creek Basin in northwestern Colorado (shown in Figure 1.1). The site is located in Rio Blanco County, as follows:

Township 3 South, Range 96 West, 6th Prime Meridian

Section 5, W1/2 SE1/4, SW1/4; Sec. 6, Lots 6 and 7, E1/2 SW1/4, SE1/4 Sec. 7, lots 1, 2, 3, 4, E1/2 W1/2, E1/2; Sec. 8, W1/2 NE1/4, NW1/4, S1/2, Sec. 9, SW1/4; Sec. 16, NW1/4, W1/2 SW1/4; Sec. 17; Sec. 18, lots 1, 2, 3, 4, E1/2 W1/2, E1/2.

Township 3 South, Range 97 West, 6th Prime Merdian

Sec. 1, S1/2; Sec. 2, SE1/4; Sec. 11, E1/2; Sec. 12; Sec. 13, N1/2; Sec. 14, N1/2 NE1/4.

1.0 INTRODUCTION AND SUMMARY

1.3 Executive Summary

.1 Tract Description (Continued)

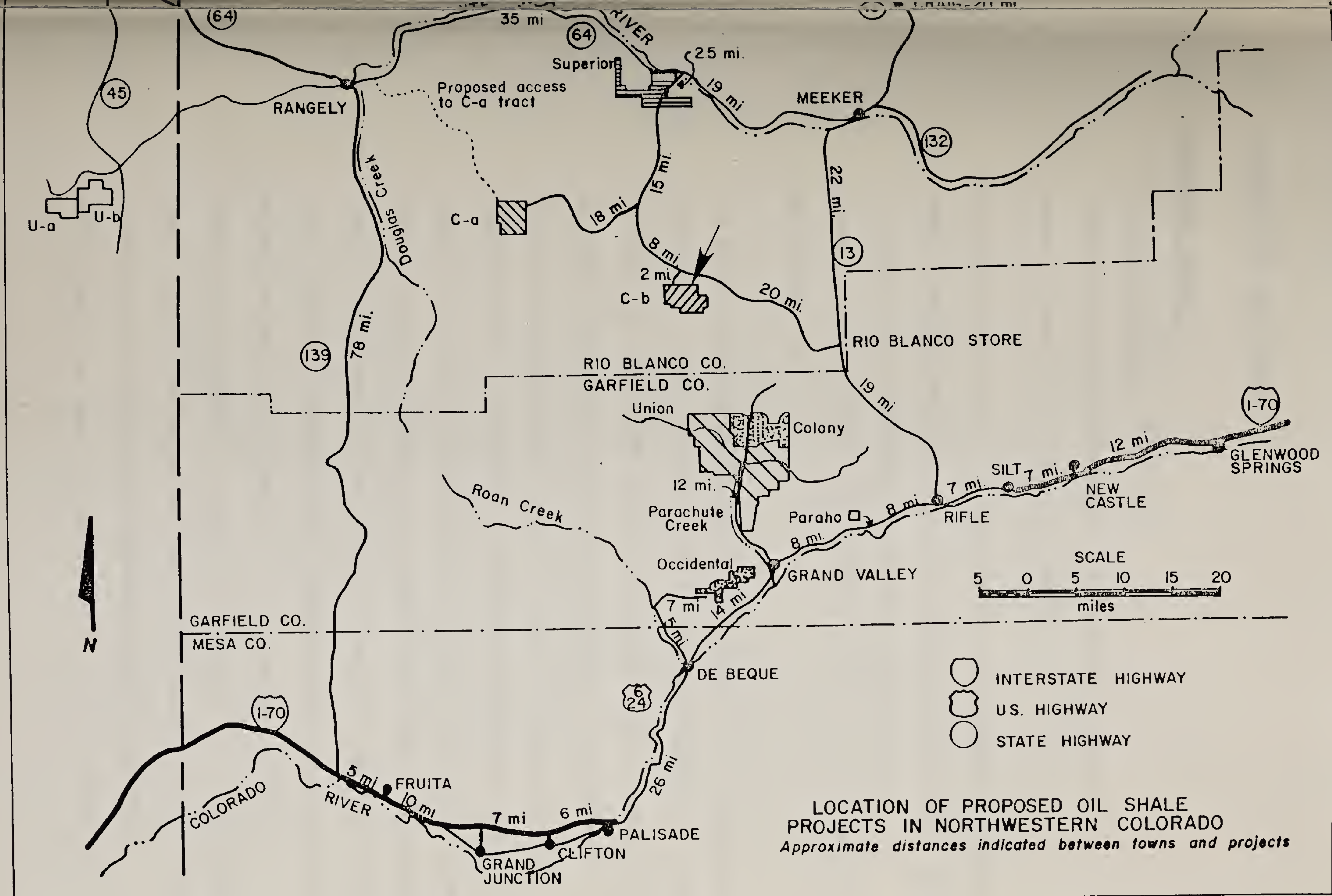
Population in this section of the county can generally be described as sparse. There are a few ranches along Piceance Creek; however, the closest major towns to the tract, Rifle and Meeker, are nearly 40 road miles away.

Terrain on the tract consists primarily of undulating valleys and ridges trending northeasterly and draining into Piceance Creek. Elevations vary from 6,400 feet in the lowest valley bottoms to 7,100 feet on the ridges at the southern edge of the site. The northern edge of the tract is approximately 1/2 mile south of Piceance Creek at the confluence with Stewart Gulch. The semirid climate supports sparse vegetation; mainly sagebrush and pinyon-juniper communities. Snow cover occurs occasionally from October to May.

Approximately 45% of the tract (primarily flat ridgetops) was chained by the federal government in 1967. Chaining is a technique used to improve range production by removing sage and pinyon-juniper. Historically, the tract has been primarily used for cattle grazing and as winter range for mule deer that migrate across the basin.

.2 Oil Shale Resource

Oil shale is a fine-grained sedimentary rock containing an organic compared called kerogen. With the application of heat



DRAWN BY VICKI SMITH

FIGURE 1.1 LOCATION OF PROPOSED OIL SHALE PROJECTS IN NORTHWESTERN COLORADO

Source: "The CB Oil Shale Venture and Socio-Economic Concerns in Western Colorado": Pace Quality Development Associates, Inc., (February 15, 1977)

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1.3 Executive Summary

.2 Oil Shale Resource (Continued)

(700-900°F), kerogen decomposes to yield light hydrocarbon gases, a coke-like residue, and shale oil.

Oil shale within Tract C-b from the top of the Parachute Creek member through the Garden Gulch and Douglas Creek members, shown in Figure 1.2, is estimated to contain nearly 13.2 billion barrels of oil in shale with variable grades, some exceeding 30 gallons per ton.

The 290-ft. stratigraphic horizon selected for MIS development contains and in-place resource of 2.82 billion barrels of shale oil over the full 5,094 acres of the tract. Restrictions such as safety regulations, design considerations, and boundary irregularities eliminate some 505 acres from the available resource base. The remaining 4,589 acres contain an in-place resource of 2.52 billion barrels of shale oil. The three-phase mining project now planned will result in an overall recovery of 1.05 billion barrels of shale oil, or some 41.8 percent of the tract's in-place resource. MIS operations will account for 63.4 percent or 668 million barrels, of such recovery; and the remaining 36.6 percent, or 386 million barrels, will be derived from surface retorting of the raw shale produced from MIS void excavation and other mine development within the selected stratigraphic horizon. An additional 27 million barrels of

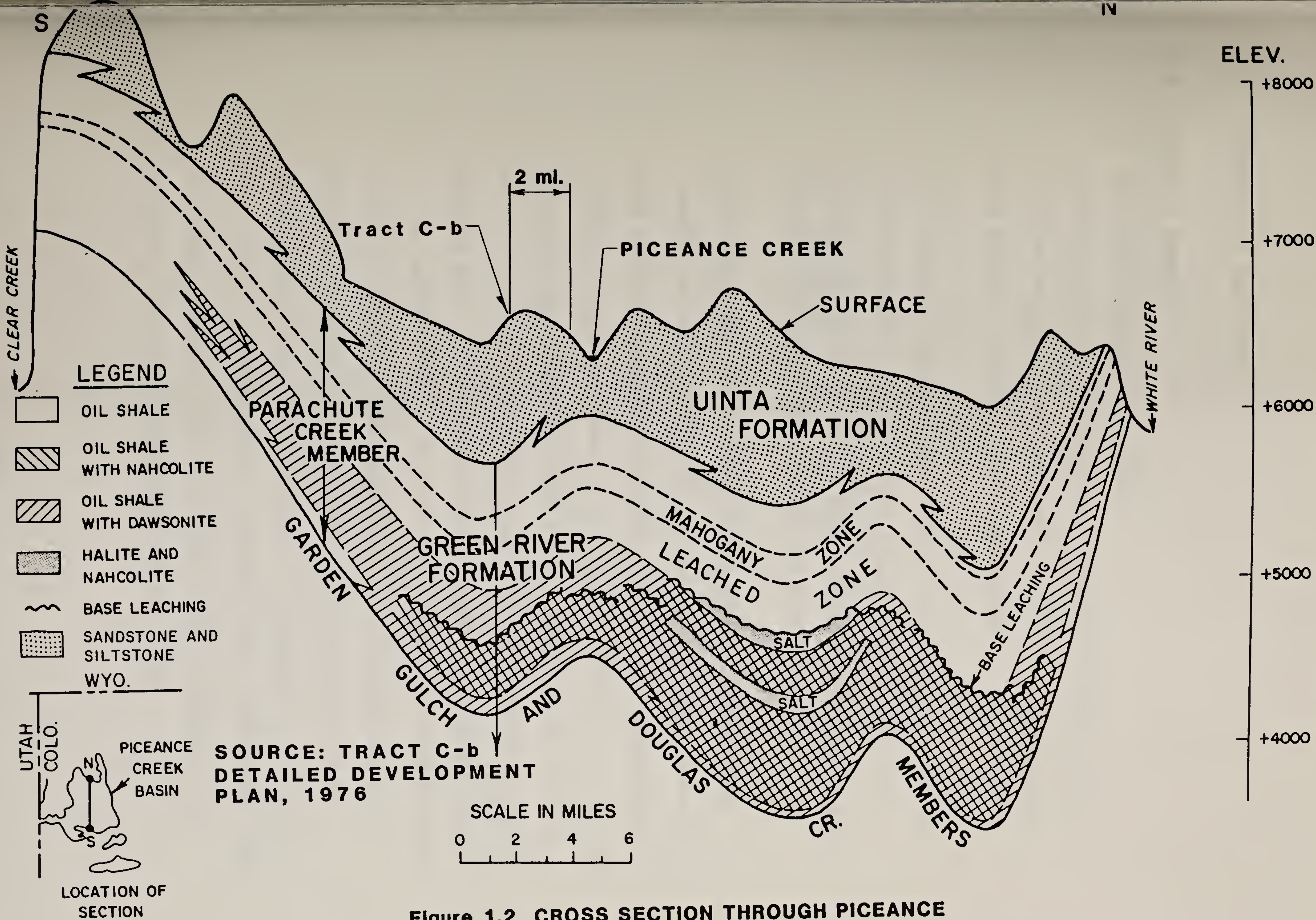


Figure 1.2 CROSS SECTION THROUGH PICEANCE CREEK BASIN

1.3 Executive Summary

.2 Oil Shale Resource (Continued)

shale oil will be recovered from surface retorting of the raw shale excavated on two mine levels that fall above and below this horizon, or outside the resource base.

The selected mining horizon, shown in Figure 1.3, through most of the Mahogany zone, below the A groove, including the B groove, and parts of the R-6 zone. Oil shale in this interval averages 27 gallons per ton over the full section.

Other Resources. Both nahcolite and dawsonite are present beneath the tract. Nahcolite is occasionally found in nodule form within the Mahogany zone, but in such small amounts that it affords no apparent commercial potential. The zone of greatest nahcolite concentration on the tract is found in the lower part of the Parchute Creek section, about 120 feet below the base of the R-4 zone. This nahcolite-bearing interval is present mainly in the western half of the the tract. Dawsonite is also present within the Mahogany zone; however, its low concentration of potentially recoverable alumina (Al_2O_3) in this area makes extraction of the mineral currently not economical. Oil, gas, and coal are other potential resources found in the area. These resources, however, offer no current economic interest since they are generally found beneath the oil shale.

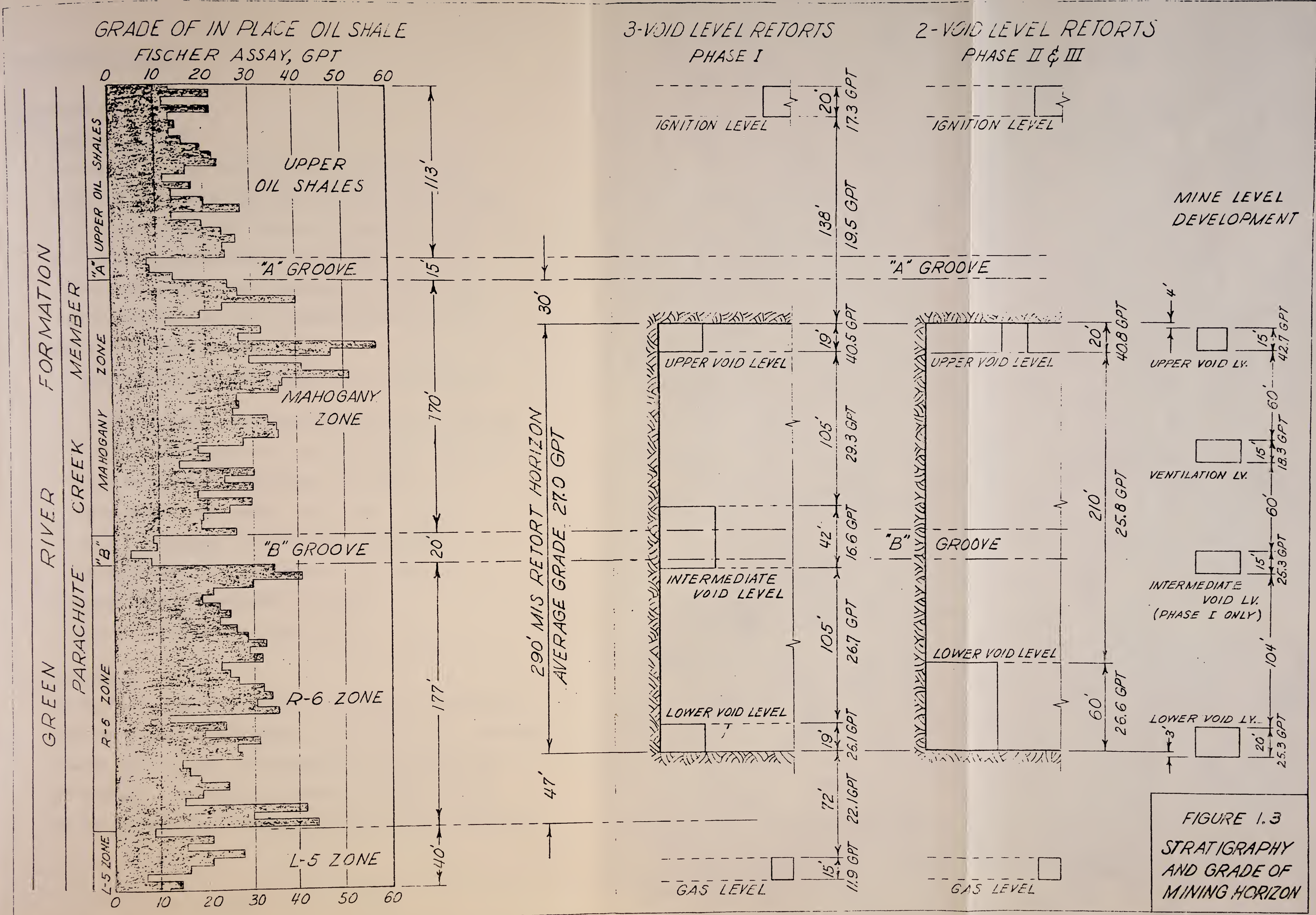


FIGURE 1.3
STRATIGRAPHY AND GRADE OF MINING HORIZON

1.3 Executive Summary

.3 Development Schedule

Figure 1.4 illustrates start-up and completion of various engineering, procurement, and construction activities proposed for Tract C-b. This master schedule represents a time span from the third quarter 1980 through plant shutdown, and includes activities for mine and shaft development, and an off-site surface development, and site reclamation milestone dates referenced in Figure 1.4 are:

Ventilation/Escape Shaft Equipped and Fully Operational - Dec. 1981

Production Shaft Equipped and Fully Operational - May 1982

Service Shaft Equipped and Fully Operational - Sept. 1982

Ignition of First In Situ Retort - May 1985

Begin Phase II Development - Early 1988

Full In Situ Retort Oil Production - August 1988

Surface Retort Facility Completed - July 1989

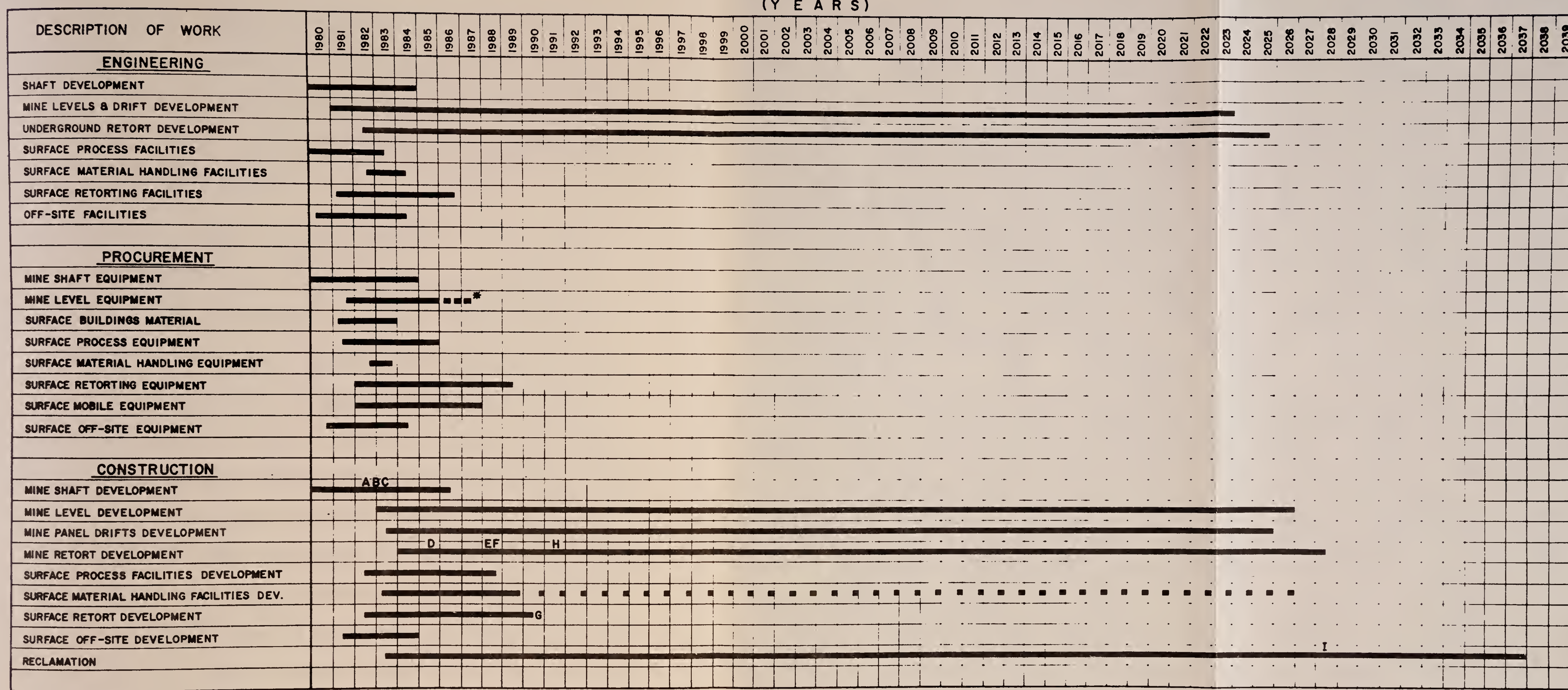
Begin Phase III Development - Mid 1991

End of First Commercial Phase - 2028

.4 MIS Process

The Modified In Situ (MIS) process is a method of retorting oil shale underground, as contrasted to conventional surface techniques in which shale is mined and transported to a surface facility for retorting. The process is conducted in chambers (called retorts) of broken shale created by blasting the rock into mined

MASTER ENGINEERING, PROCUREMENT AND CONSTRUCTION DEVELOPMENT SCHEDULE



* IS A CONTINUOUS ACTIVITY THROUGH MINE DEVELOPMENT

MILESTONES:

A. VENTILATION / ESCAPE SHAFT EQUIPPED AND FULLY OPERATIONAL.
B. PRODUCTION SHAFT EQUIPPED AND FULLY OPERATIONAL.
C. SERVICE SHAFT " " " " .
D. IGNITE FIRST IN SITU RETORT.
E. BEGIN PHASE II DEVELOPMENT.
F. FULL IN SITU RETORT OIL PRODUCTION.
G. SURFACE RETORT FACILITIES COMPLETED.
H. BEGIN PHASE III DEVELOPMENT.
I. END OF FIRST COMMERCIAL PHASE.

Fig. 1.4 MASTER ENGINEERING, PROCUREMENT AND CONSTRUCTION SCHEDULE

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.4 MIS Process (Continued)

out voids. In situ retorts on Tract C-b will have a common 290-ft. height. Only the cross sectional area of the retorts, the number of their void development levels, and the pillar size between them will vary for each of the three development phases called for in the mining plan.

The operation of a retort consists of several steps. First, the top of the retort is kindled by burners until sufficient temperature to sustain reaction is reached. The burners are then shut off and a regulated mixter of air and steam is drawn into and through the retort by exhaust blowers on the surface. Residual carbon left with the oil shale rock after the kerogen decomposes provides fuel for the combustion front, which provides heat to maintain the retorting action. Steam is injected to control combustion front temperature (maintained at approximately 1600°F). As the vapor and gas mixture flows down through the retort, the raw shale below is preheated. At the same time, the oil and some of the vapor condense on the cooler shale and flow out the bottom of the retort. Product liquids are collected in gravity sumps below the retorts and pumped to the surface for final separation and cleaning.

Retorting progresses slowly (about 1 foot per day) through the retort height for approximately 293 days. When completed, the

1.0 INTRODUCTION AND SUMMARY

1.3 Executive Summary

.4 MIS Process (Continued)

air and steam feed are halted and the in situ retort is closed off at the top. Processed shale remains underground eliminating the need for surface disposal. There is, however, a vast volume of shale mined to prepare MIS retorts that must be transported to the surface, processed, and disposed of on the tract. Handling mined shale is the topic of the following section.

.5 Handling Raw and Processed Shale

Raw oil shale is initially stockpiled at the rate depicted in Figure 1.5. Stockpiling is necessary prior to full surface retorting capacity (reached in mid-1990) because the quantity of raw shale produced exceeds the amount needed to satisfy surface retorting requirements. Figure 1.6 graphically illustrates this difference. After seven surface retorts are activated, the quantity of raw shale needed exceeds the amount produced from the mine and, consequently, raw shale is removed from the stockpile to supplement mine-produced shale. Current projections indicate that the raw shale stockpile will be depleted in 2011. Raw shale will be stored entirely in Cottonwood Gulch.

Raw shale will be conveyed to a truck load-out hopper after being split from the material going to surface retorting. End dump trucks (120 ton) will haul the shale from the load-out facility to the working face of the pile. Because the raw shale is

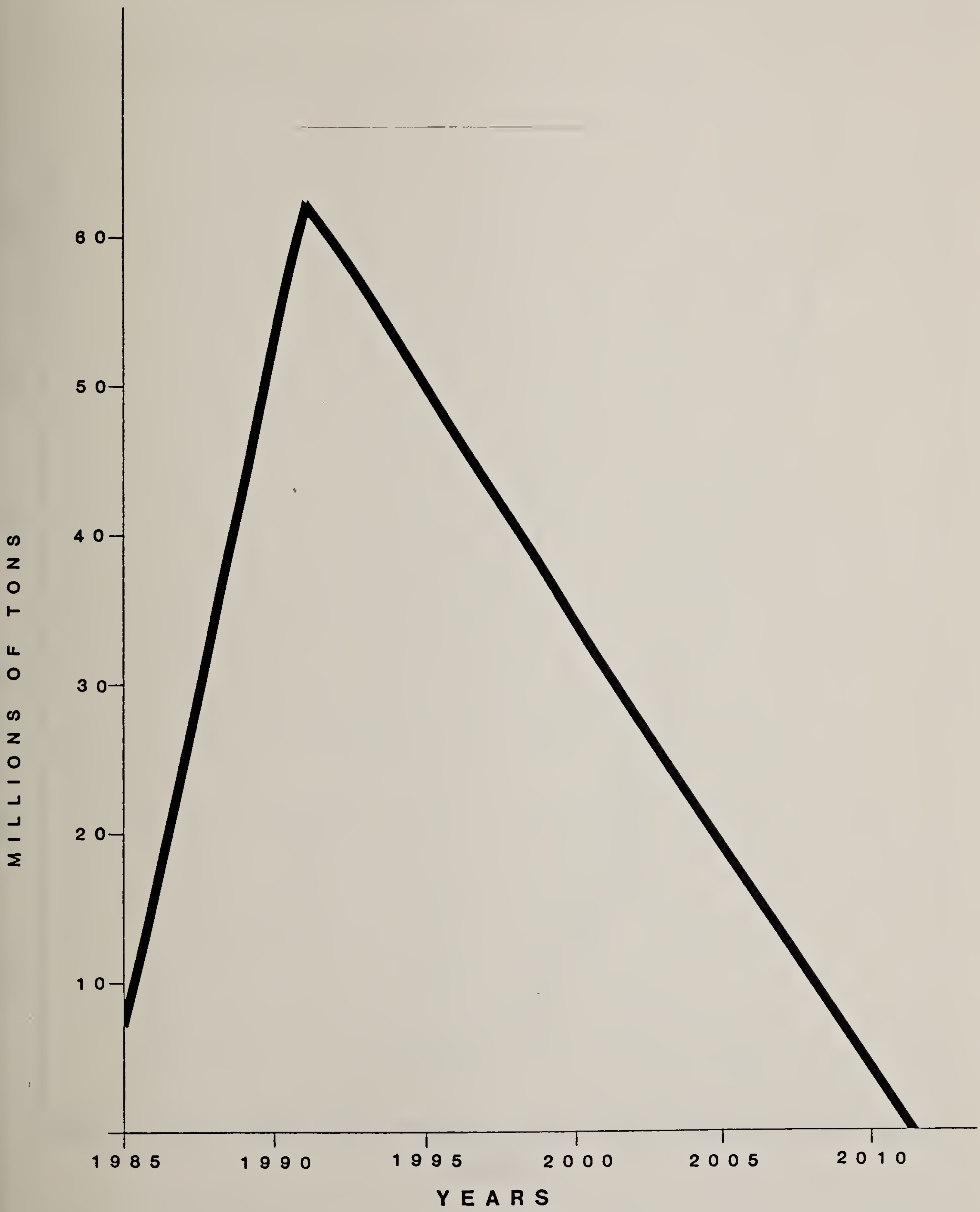
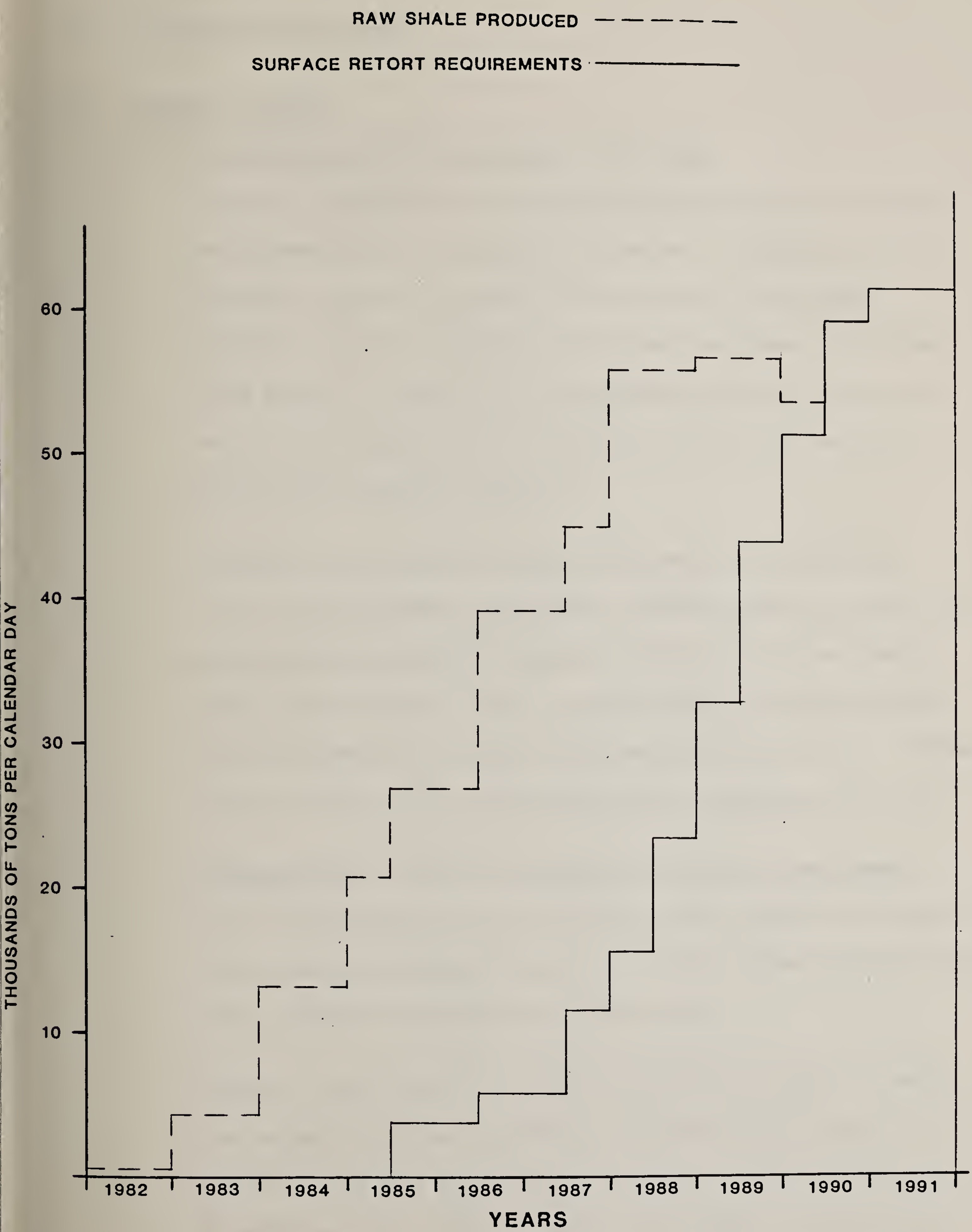


Figure 1.5 RAW SHALE STOCKPILE VOLUME



gure 1.6 RAW SHALE PRODUCED AND SURFACE RETORT REQUIREMENTS

1.3 Executive Summary

.5 Handling Raw and Processed Shale (Continued)

damp as it emerges from the mine, excess dust should be minimal when dumped in the storage pile. However, if fugitive dust is generated a sprinkler system will be provided. Bulldozers will push raw shale onto the working face and shape side slopes. Since there is a possibility of spontaneous heating of the raw shale pile, compaction may be required to limit air necessary to sustain the exothermic reaction.

Because of the temporary nature of the raw shale stockpile, it will not be covered with topsoil and revegetated. Instead, an environmentally acceptable chemical stabilizer will be used to control pile erosion. While the pile is being depleted, topsoil earlier stored will be used to reclaim the affected area. Reclamation activities will include grading and revegetating the site.

Processed Shale. All shale produced during mine development will be processed in surface retorts, which results in an approximate quantity of 505 million tons. A final volume of 415 million cubic yards must be disposed of on the site.

Hydraulic backfilling MIS retorts with processed shale is being studied as a possible alternative of disposing this waste, however, since this would require an estimated 4,000 acre-feet of water per year, hydraulic backfilling appears unlikely for Tract C-b. Instead, processed shale will be stored in Sorghum

.5 Handling Raw and Processed Shale (Continued)

Gulch due to its proximity to treatment facilities, the small watershed above the proposed site, and the capability of constructing the pile so processed shale wil not extend beyond the ridge line into Stewart Gulch.

After processed shale emerges from the surface retorts, a covered conveyor moves the material to the processed shale handling and treatment building where gypsum from the gas treatment facility, ash from the incinerator, and water for proper dust control and compaction are blended. Covered belt conveyors transfer the treated processed shale to load-out hoppers where diesel-powered end-dump trucks deliver the material to the working area for shaping and compacting.

The reclamation plan for the processed shale disposal area calls for covering the pile with topsoil and revegetating as soon as practical after the pile reaches its final size in any area. Initial preparation of the disposal site will entail removing topsoil or soil-like material from the area where the processed shale will first be deposited, and creating a topsoil stockpile in the Scandard Gulch area. This topsoil pile will be revegetated for storage until the end of the project, and then will be used for reclaiming the final portion of the processed shale disposal pile in Cottonwood Gulch. As the processed shale disposal area

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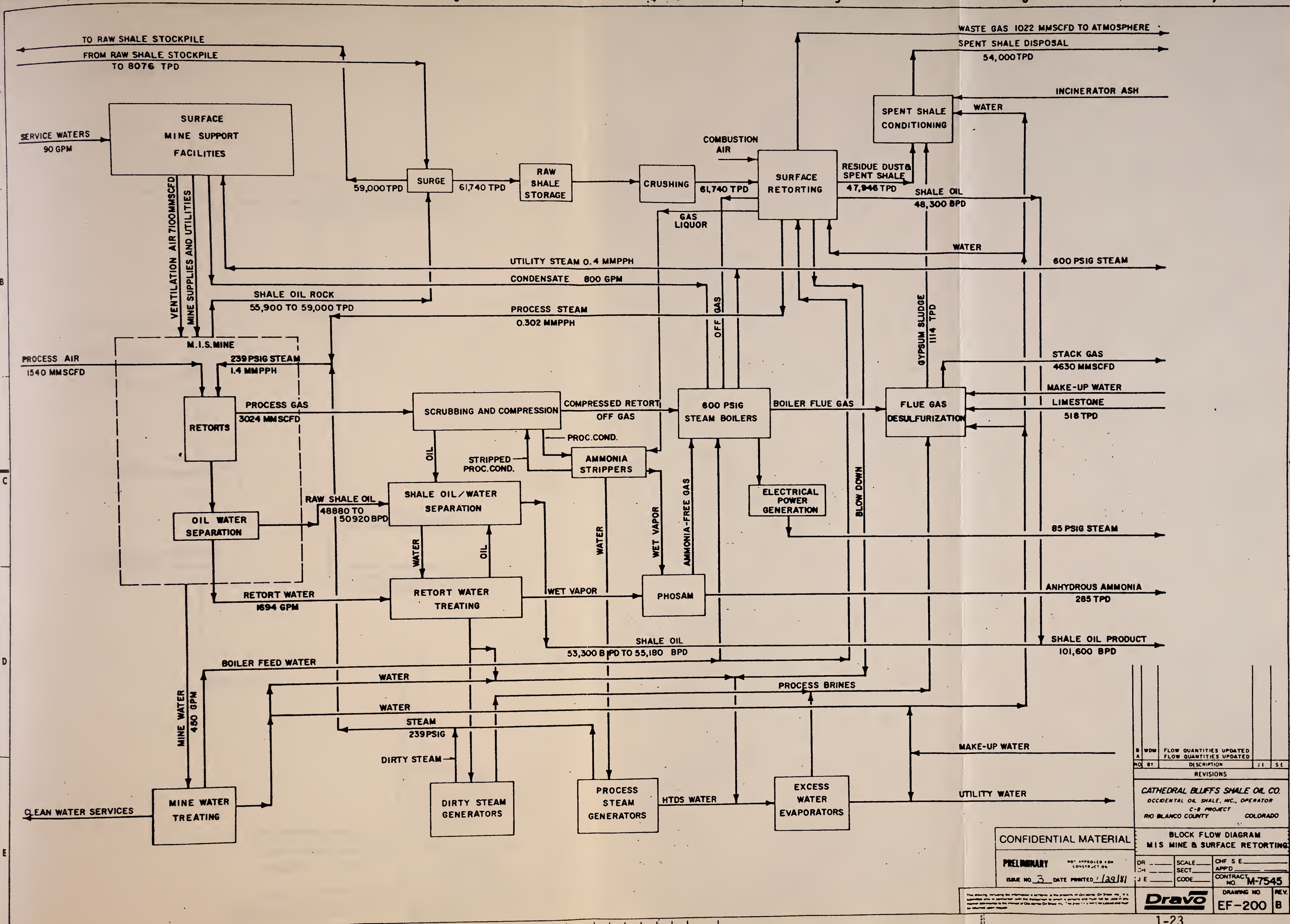
.5 Handling Raw and Processed Shale (Continued)

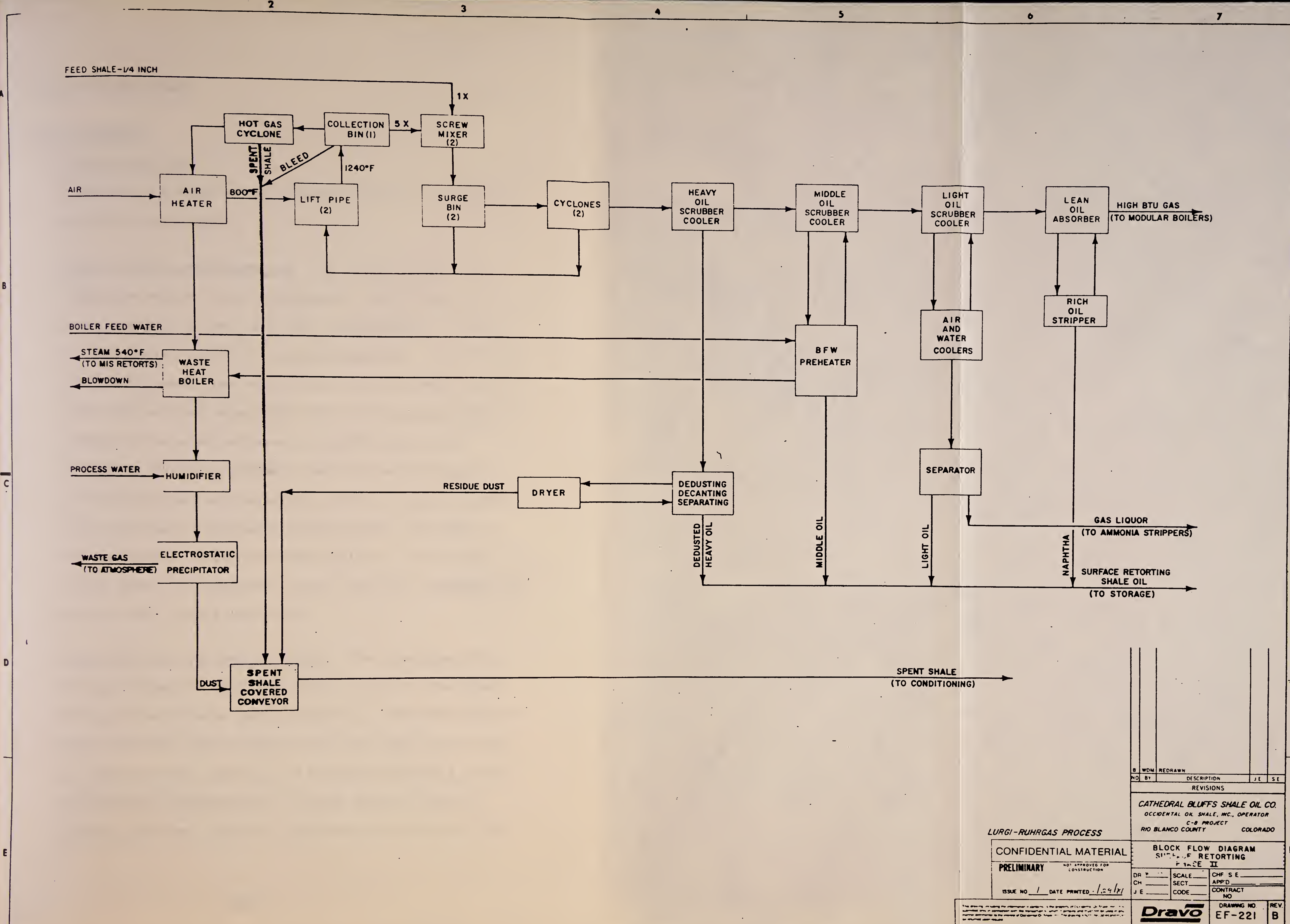
progresses through the life of the project, topsoil will be stripped ahead of the advancing pile and either immediately deposited on completed portions or temporarily stored for reclamation purposes.

.6 Surface Facilities

The surface process facilities, which include shale oil/water separation and treatment, MIS offgas combustion, MIS offgas scrubbing and compression, steam generation and power production, ammonia by-product recovery, flue gas desulfurization, water management, and shale oil storage and shipping, and miscellaneous utilities, are provided to primarily process products generated from MIS retorts. Common facilities also serve surface retorts. The following paragraphs briefly summarize each section of the surface process facilities, and drawing EF-200 is provided to illustrate the flow of products through this proposed arrangement.

Shale Oil/Water Separation. After MIS raw shale oil and process retort water are separated in an underground sump, each is pumped to the surface. The raw shale oil is treated to separate any emulsified water and solids before going to storage. Before process retort water may be used for steam generation and utility for steam generation and utility water, remaining oil, dissolved organic material, and sludge must be removed.
Oil separation and process retort water treating are closely


TO RAW SHALE STOCKPILE
FROM RAW SHALE STOCKPILE
TO 8076 TPD
SERVICE WATERS
90 GPM
SURFACE MINE SUPPORT FACILITIES
VENTILATION AIR 7100 MMSCFD
MINE SUPPLIES AND UTILITIES
59,000 TPD
SURGE
61,740 TPD
RAW SHALE STORAGE
CRUSHING
61,740 TPD
COMBUSTION AIR
SURFACE RETORTING
WASTE GAS 1022 MMSCFD TO ATMOSPHERE
SPENT SHALE DISPOSAL
54,000 TPD
INCINERATOR ASH
WATER
SPENT SHALE CONDITIONING
RESIDUE DUST & SPENT SHALE
47,946 TPD
SHALE OIL
48,300 BPD
GAS LIQUOR
WATER
UTILITY STEAM 0.4 MMPPH
600 PSIG STEAM
CONDENSATE 800 GPM
SHALE OIL ROCK
55,900 TO 59,000 TPD
PROCESS STEAM
0.302 MMPPH
OFF GAS
GYPSUM SLUDGE 1114 TPD
M.I.S. MINE
PROCESS AIR
1540 MMSCFD
239 PSIG STEAM
1.4 MMPPH
STACK GAS
4630 MMSCFD
MAKE-UP WATER
LIMESTONE
518 TPD
RETORTS
PROCESS GAS
3024 MMSCFD
SCRUBBING AND COMPRESSION
COMPRESSED RETORT OFF GAS
600 PSIG STEAM BOILERS
BOILER FLUE GAS
FLUE GAS DESULFURIZATION
PROC. COND.
STRIPPED PROC. COND.
AMMONIA STRIPPERS
OIL
ELECTRICAL POWER GENERATION
BLOW DOWN
RAW SHALE OIL
48880 TO 50920 BPD
SHALE OIL/WATER SEPARATION
OIL WATER SEPARATION
85 PSIG STEAM
WATER
OIL
WATER
WET VAPOR
AMMONIA-FREE GAS
RETORT WATER
1694 GPM
RETORT WATER TREATING
WET VAPOR
PHOSAM
ANHYDROUS AMMONIA
285 TPD
SHALE OIL
53,300 BPD TO 55,180 BPD
SHALE OIL PRODUCT
101,600 BPD
BOILER FEED WATER
WATER
PROCESS BRINES
WATER
MINE WATER
450 GPM
STEAM
239 PSIG
DIRTY STEAM
MAKE-UP WATER
CLEAN WATER SERVICES
MINE WATER TREATING
DIRTY STEAM GENERATORS
PROCESS STEAM GENERATORS
HTDS WATER
EXCESS WATER EVAPORATORS
UTILITY WATER
B WDM FLOW QUANTITIES UPDATED
A FLOW QUANTITIES UPDATED
NO BY DESCRIPTION
REVISIONS
CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO
CONFIDENTIAL MATERIAL
BLOCK FLOW DIAGRAM
MIS MINE & SURFACE RETORTING
PRELIMINARY
ISSUE NO 3 DATE PRINTED 1/29/81
CONTRACT NO. M-7545
Dravo
DRAWING NO. EF-200
REV. B



FEED SHALE-1/4 INCH
1X
HOT GAS CYCLONE
COLLECTION BIN (1)
5 X
SCREW MIXER (2)
SPENT SHALE
BLEED
1240°F
AIR
AIR HEATER
800°F
LIFT PIPE (2)
SURGE BIN (2)
CYCLONES (2)
HEAVY OIL SCRUBBER COOLER
MIDDLE OIL SCRUBBER COOLER
LIGHT OIL SCRUBBER COOLER
LEAN OIL ABSORBER
HIGH BTU GAS (TO MODULAR BOILERS)
RICH OIL STRIPPER
AIR AND WATER COOLERS
BOILER FEED WATER
BFW PREHEATER
STEAM 540°F (TO MIS RETORTS)
BLOWDOWN
WASTE HEAT BOILER
PROCESS WATER
HUMIDIFIER
RESIDUE DUST
DRYER
DEDUSTING DECANTING SEPARATING
SEPARATOR
GAS LIQUOR (TO AMMONIA STRIPPERS)
DEDUSTED HEAVY OIL
MIDDLE OIL
LIGHT OIL
NAPHTHA
SURFACE RETORTING SHALE OIL (TO STORAGE)
WASTE GAS (TO ATMOSPHERE)
ELECTROSTATIC PRECIPITATOR
DUST
SPENT SHALE COVERED CONVEYOR
SPENT SHALE (TO CONDITIONING)
LURGI-RUHRGAS PROCESS
CONFIDENTIAL MATERIAL
PRELIMINARY
NOT APPROVED FOR CONSTRUCTION
ISSUE NO. 1
B WDM REDRAWN
NO BY DESCRIPTION JE SE
REVISIONS
CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO
BLOCK FLOW DIAGRAM
RETORTING
DR
CH
JE
SCALE
SECT
CODE
CHF S E
APP'D
CONTRACT NO
Dravo
DRAWING NO
EF-221
REV.
B

integrated as a result of the presence of water in raw shale oil and oil in retort water.

Offgas Scrubbing and Compression. The offgas scrubbing and compression section receives low-Btu MIS retort offgas, at approximately 65 Btu per cubic foot, subatmospheric pressure, and approximately 150°F via an underground shaft. This flow is equally split among four aprallel gas scrubbing trains, with a fifth train provided as a spare. Each train consists of a combination precooler and ammonia scrubbing tower, with auxiliaries, followed by blowers, which deliver the gas at sufficient pressure and temperature (225°F) to special low-Btu burners provided in the modular steam boilers. The tower in each train cools the gas, condenses additional water, and removes ammonia for byproduct recovery and sulfur compounds for fuel by direct contact with water.

Steam Generation and Power Production. The steam generation and power production facilities serve to make the mine almost self-sufficient from an energy standpoint. Ten modular boilers produce 600 PSIG, 750°F steam in sufficient quantity to supply all steam needs and generate 13.8 kilovolt electricity in five noncondensing turbogenerators, of which three or four are normally operating. Normally, sufficient electricity will be

1.3 Executive Summary

.6 Surface Facilities (Continued)

generated to export a portion to the outside power grid; only in extremely cold weather will power be imported. Five steam pressure levels will be available: 600 PSIG, 300 PSIG, 239 PSIG, 85 PSIG, and 20 PSIG. These are in addition to the 412 PISG steam, which is available from the surface retorts and fed directly to the mine along with the 239 PSIG steam.

Flue Gas Desulfurization. The flue gas desulfurization section consists of five, two-step contactors to remove sulfur dioxide from the flue gas by reacting it with limestone in slurry form. The selected process, the Research-Cottrell Double Loop Limestone Process, has the advantages of high sulfur dioxide removal, high reagent utilization, and high reliability. The induced draft fan provided with each modular boiler is sized to generate sufficient pressure to accommodate the absorbers. Reacted lime will be mixed with surface retorted shale in the processed shale conditioning area for surface disposal.

Water Management. The water management section recycles water from MIS retorts so the plant is self-sufficient from a water standpoint and produces no contaminated effluent.

Byproduct Recovery. The byproduct recovery section produces high-quality fertilizer-grade anhydrous ammonia for sale using the US Steel Corporation's Phosam W Process.

1.0 INTRODUCTION AND SUMMARY

1.3 Executive Summary

.6 Surface Facilities (Continued)

Product Storage and Shipping. The product storage and shipping section includes tankage for about ten days storage of shale oil and ammonia, or 1,120,000 barrels and 2,850 tons repspectively. Shale oil will be transported via an oil shale pipeline provided by others. Ammonia will be trucked to a rail trans-shipment point in Rifle, Colorado.

Miscellaneous Utilities. Various utilities including emergency power, auxiliary fuel, cooling water, compressed air, inert gas, and the flare system are included in the surface process facilities.

Surface retorts will be a major element of surface operations. Eight Lurgi-Ruhrgas (LR) process modules will be installed sequentially between 1985 and 1990. On the average, seven units will operate while one is out of commission for service and maintenance; however, all systems are designed to accomodate an eight-module operation.

The LR process was selected over other surface technologies because of the following factors:

- Technology has proven high yields;
- Development is ready for commercial scaling;
- Equipment is proven for similar processes; and
- License does not involve competing U.S. energy companies.

1.0 INTRODUCTION AND SUMMARY

1.3 Executive Summary

.6 Surface Facilities (Continued)

Four sections comprise the LR oil shale retorting process: distillation and circulation; waste heat recovery and waste gas treatment; condensation; and heavy oil dedusting. Flow is depicted in drawing EF-221.

Average feed capacity of eight surface modules exceeds average mine production. The balance of feed requirements is made up from previously stockpiled raw shale. Table 1.1 shows the expected raw shale production, surface processing requirements, and stockpile rates from initial surface module operation in July 1985 through eight-module operation in 1990.

.7 Environmental Impacts and Control Procedures

Air Quality Control. Section 11 of the Lease and Section 8 of the Lease Environmental Stipulations require complicance with all applicable federal, state and local air pollution and air quality regulations, including emission regulations limiting the quantities of air contaminants which can be emitted from various sources, and ambient air quality standards which define maximum permissible ground level concentrations of various air contaminants. Ambient air quality standards, which have been promulgated to protect public health and welfare, are of particular importance since they define the maximum permissible level of impacts from the proposed operations.

1-28

Phase	Retort Module No.	Fraction[6]	Period	Average Raw Shale Production[1,3] TPSD	TPCD	Raw Shale To Stockpile[1,3] TPSD	TPCD	Shale Crushing And Screening[2,3] TPSD	TPCD	Surface Retorting Oil Production[2] BPSD	BPCD
I	1	0.5	July 1985 - July 1986	27,945	26,830	23,918	22,971	4,410	3,859	2,760	2,415[4]
I	1	0.75	July 1986 - July 1987	40,690	39,060	34,657	33,271	6,615	5,789	4,140	3,620[4]
I	2	1.5	July 1987 - Jan. 1988	57,500	55,200	46,026	44,185	13,230	11,575	8,280	7,245[4]
I	3	2.0	Jan. 1988 - July 1988	59,000	56,640	42,922	41,205	17,640	15,435	11,040	9,660[4]
I	4	3.0	July 1988 - Jan. 1989	59,000	56,640	34,882	33,487	26,460	23,153	16,560	14,490[4]
I	5	4.25	Jan. 1989 - July 1989	59,000	56,640	24,833	23,840	46,855	32,800	23,460	20,530[4]
I	6	5.675	July 1989 - Jan. 1990	59,000	56,640	13,378	12,843	50,055	43,797	31,325	27,410[4]
II	7	6.675	Jan. 1990 - July 1990	55,900	53,664	2,238	2,149	58,875	51,515	46,060	40,300[5]
II	8	7.675	July 1990 - Jan. 1991	55,900	53,664	-5,800	-5,568	67,695	59,232	52,960	46,340[5]
II	8	8.0	Jan. 1991 -	55,900	53,664	-8,412	-8,076	70,560	61,740	55,200	48,300[5]

Notes:
1. Mining Availability Factor 0.960 (350 days/yr)
2. LR-Retorting Availability Factor 0.875 (319 days/yr)
3. Only calendar day rates are additive for different stream factors
4. Based on 24 GPT average assay
5. Based on 30 GPT average assay
6. Initial capacity of retort module reduced at startup

1.3 Executive Summary

.7 Environmental Impacts and Control Procedures (Continued)

To achieve compliance with rigid air quality regulations, Cathedral Bluffs will utilize the best available control technology and state-of-the-art pollution control devices. Chemical soil stabilizers, water sprays and prompt revegetation will keep dust emissions from earth-moving and construction activities to a minimum. Dry-fabric collection devices (baghouses), water sprays, and scrubbers will control dust resulting from materials handling (hoisting, conveying, etc.). A flue gas desulfurizer will limit stack emissions from the Surface Process Facility and several emission-control components, such as electro-static precipitators, are supplied with the Lurgi surface retorts.

Water Pollution Control. The potential for water pollution exists in all phases of activity. The major activities and facilities proposed which could affect water quality are: 1) construction, 2) mining, 3) processing facilities, 4) raw shale stockpile, 5) processed shale disposal, 6) on-tract product storage, and 7) off-tract facilities.

Section 11 of the Lease and Section 9 of the Lease Environmental Stipulations for Tract C-b require that the Lesee carry out all operations on the tract in compliance with federal, state and local laws and regulations.

1.0 INTRODUCTION AND SUMMARY

1.3 Executive Summary

.7 Environmental Impacts and Control Procedures (Continued)

Numerous federal laws and regulations deal in some way with water pollution control. The Federal Water Pollution Control Act (FWPCA), and amendments and regulations adopted by EPA under its provisions, will require 1) the preparation and implementation of oil spill contingency plans for storage tanks and pipelines, and 2) a National Pollutant Discharge Elimination Systems (NPDES) permit for effluents leaving the plant. While the project is expected to be a net consumer of water, the uncertainties relating to mine water inflow may require controlled discharge to Piceance Creek. Such discharges would require a NPDES permit.

Some parts of the Clean Water Act (CWA) -- specifically, Section 208 and 106 relate to the protection of ground water. The Safe Drinking Water Act (SDWA) through its underground injection control and sole aquifer protection provisions and the Resource Conservation and Recovery Act (RCRA) provide for control of certain hazardous practices and some protection for highly vulnerable areas. Other EPA statutes which regulate toxic substances and pesticides apply as well. Additionally, the Colorado River Basin Salinity Control Act limits salinity of the Colorado by regulation of discharges to contributing water systems.

1.3 Executive Summary

.7 Environmental Impacts and Control Procedures (Continued)

State Laws and Regulations. The Colorado Water Quality Control Act and regulations thereunder establish stream water quality standards and discharge criteria for pollutants. The Act is administered by the Water Quality Division of the Colorado Department of Health. This division also administers the NPDES permit programs by agreement with EPA.

The Division and the Water Quality Control Commission administer and regulate the reinjection of water into underground disposal wells, as well as underground disposal of wastes. Any disposal of water by reinjection or underground waste disposal requires public hearings and the approval of the Commission.

Cathedral Bluffs will implement the necessary plans and procedures to assure compliance with these stringent regulations.

Erosion Control Plan. The scope of the erosion control plan includes the control of wind and water erosion by utilizing appropriate construction, operational and reclamation methods to minimize the short and long term environmental impacts of the development and eventual abandonment of the C-b Tract.

Cathedral Bluffs will rehabilitate lands disturbed during the development of oil shale resources on the tract in a manner consistent with good ecological practices, economic feasibility

1.3 Executive Summary

.7 Environmental Impacts and Control Procedures (Continued)

and practical land use considerations. Lease Stipulation 11.A requires that "reclaimed land [be] in a usable non-hazardous condition such that soil erosion and water pollution are avoided or minimized". To accomplish these goals, a revegetation plan has been developed to:

- Stabilize and control erosion on disturbed surfaces by using proven plant materials;
- support animal populations at least as extensive as those presently on the tract;
- coordinate the natural processes of ecosystem recovery which occur independent of man by using the best available management practices; and
- assure compatibility with existing adjacent undisturbed natural areas.

According to the C-b Tract lease, the capability of revegetating disturbed areas must be demonstrated. A program to obtain the required technology is underway and must be successful by the tenth lease year.

Others. the DDP contains several other environmental control plans. These include:

- o Spill Contingency;
- o Fire Control;
- o Waste Management;
- o Aesthetic and Scenic Resources;
- o Archaeological, Historic, and Scientific Values;

1.3 Executive Summary

.7 Environmental Impacts and Control Procedures (Continued)

- o Noise Control;
- o Fish and Wildlife;
- o Subsidence Control;
- o Health and Safety;
- o Off-Tract Corridors; and
- o Abandonment Plans.

.8 Capital and Operating Costs

The cost estimate for the C-b Oil Shale Project is summarized in Table 1.2.

Table 1.2 C-b Project Cost Summary
(Grand Total Amounts--Thousands of Dollars, Unescalated 1980)

Description	Capital Cost	Annual Steady-State Operating Cost
Mine Support and In Situ Processing	1,100,742	233,258
Surface Process Facilities	794,714	14,362
Surface Retorting Facilities	565,468	78,050
Materials Handling	24,469	*
Off-site Water Facilities	24,189	5,492
Environmental Control	121,524	9,182
Socioeconomics	95,100	*
TOTAL	2,726,206	340,344

* Not available

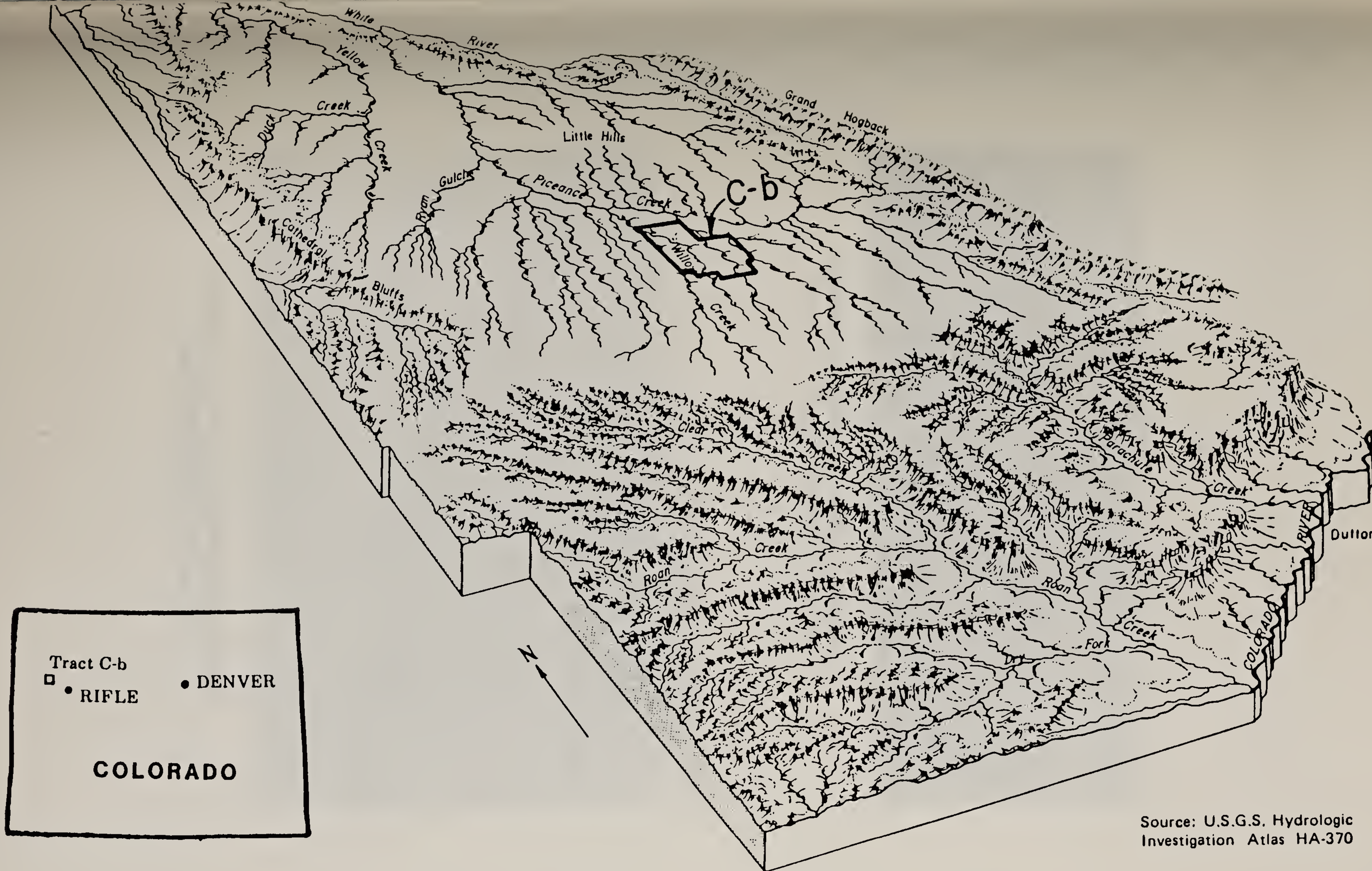
2.0 SITE DESCRIPTION

2.1 Introduction

Oil Shale Tract C-b is located in a sparsely populated region known as the Piceance Creek Basin in Rio Blanco county in northwestern Colorado. The tract consists of nearly 5,100 acres of federally-owned land situated 40 miles from the towns of Meeker and Rifle, and 65 miles from Rangely (see Figures 2.1 and 2.2).

Terrain on the tract consists primarily of undulating valleys and ridges trending northeasterly and draining into Piceance Creek. Elevations vary from 6,400 feet in the lowest valley bottoms to 7,100 feet on the ridges at the southern edge of the site. The northern edge of the tract is approximately 1/2 mile south of Piceance Creek at the confluence with Stewart Gulch. The semiarid climate supports sparse vegetation; mainly sagebrush and pinyon-juniper communities. Snow cover occurs occasionally from October to May. In 1967, the federal government used a technique called chaining, a method involving sage and pinyon-juniper removal to improve range production, on approximately 45 percent of the tract (primarily flat ridgetops). Figures 2.3 through 2.6 show various representative views of the tract.

This section describes the tract's existing site characteristics and environmental setting largely based on data collected during an environmental baseline program conducted from November 1974 to October 1976. To date, there are little substantive changes to report since this five-volume document was submitted. Interested readers are referred to the final baseline report for details not contained in this description.



Source: U.S.G.S. Hydrologic Investigation Atlas HA-370

Figure 2.1 LOCATION OF TRACT C-b

Figure 2.3 VIEW OF TRACT LOOKING SOUTH ACROSS PICEANCE CREEK

Figure 2.4 VIEW LOOKING NORTHEAST ACROSS SORGHUM GULCH

Figure 2.5 TYPICAL CHAINED AREA BETWEEN COTTONWOOD GULCH AND SUPPORT FACILITY

Figure 2.6 VIEW LOOKING NORTH DOWN COTTONWOOD GULCH

2.0 SITE DESCRIPTION

2.2 Geology and Mineral Resources

.1 Geology

The Piceance Creek basin is a northwest to southeast trending structural and sedimentary basin. In general, it is an elevated area that is part of the Colorado Plateau Physiographic Province. The tract is located on the boundary between the upland slope and basin interior subregions of the Piceance Basin.

Tract topography is characterized by a series of northeast trending linear ridges that are relatively wide and convex, or flat-topped in transverse cross-sections. In general, the divided areas rise sharply about 200-250 feet above valley floors and then gently slope 100-150 feet to the ridge crests. In logitudinal cross-section, the ridges slope uniformly northward at a rate of about 120 feet/mile. Main valleys, such as East Fork Stewart Gulch, Middle Fork Stewart Gulch, Scandard Gulch, Little Scandard Gulch, and Willow Creek, are relatively narrow, flat-bottomed, and steep-sided. Smaller drainages like Sorghum Gulch and Cottonwood Gulch have V-shaped transverse cross-sections. Both major and minor valley walls are asymmetric. Main valleys have northward gradients of 80-120 feet/mile across the tract, and minor drainages are much steeper, with gradients of 200-300 feet/mile. Figure 2.7 shows surface geology of the tract and surrounding area.

The tract contains a sedimentary sequence that is intermediate between the section present at the outcrop and the section near

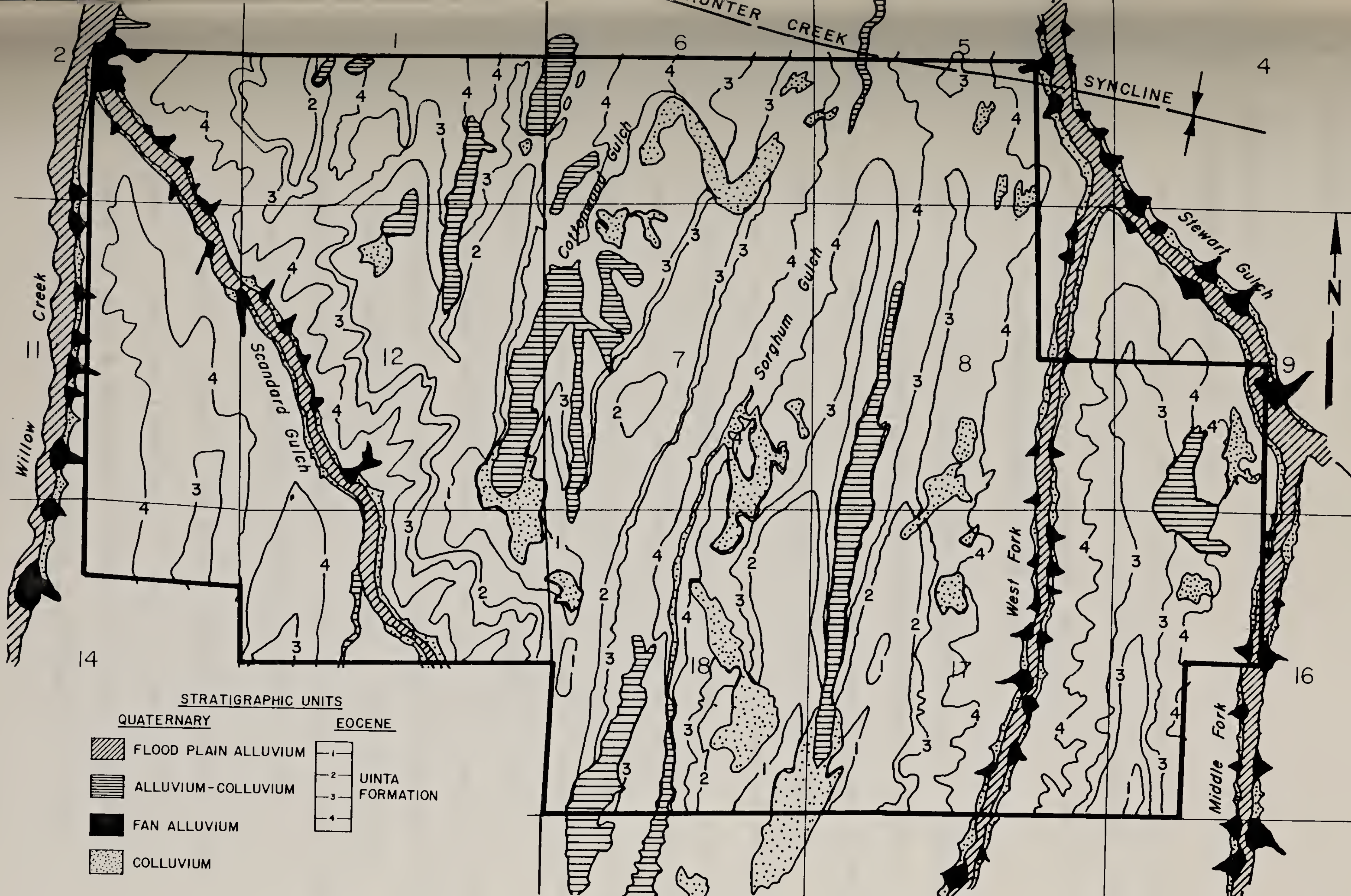


Figure 2.7 SURFACE GEOLOGIC MAP
TRACT C-b AND VICINITY

2.2 Geology and Mineral Resources

.1 Geology (Continued)

the basin depocenter. The Unita formation comprises the surface bedrock over the entire tract. This unit, which consists mostly of interbedded sandstone, siltstone and marlstone, ranges from about 400 to 900 feet thick across the tract.

Seven soil series have been identified and mapped on the tract and surrounding 1-mile area. These include Redcreek-Rentsac complex, Retsac Channery, Piceance Loam, Forelle Loam, Glendive Loam, Hanley Loam, and Hagga Loam. Physical and chemical analysis indicates that the soils are light or medium textured and fall in four categories: sandy loam, sandy clay loam, clay loam, and silty clay loam. The percentage of organic matter is generally moderate, but the lime concentration is markedly high in all soils. As might be expected, the soils have a high pH, typically greater than 7.9. Some pH values are near 9.0. Nitrate values are high in all the soils. Potassium and phosphorous levels are low in all soils except the Glendive and Hanly Loams. All soils studied are deficient in zinc. Salts are low to moderate except in the Glendive and Hanly Loams, in which they are excessive and possibly deleterious to vegetation.

In the geologic study of the tract, abundant fracturing was found in the Uinta Formation. Fracturing and faulting are important from a pedological viewpoint because fractures in parent material provide different environments for soils

2.0 SITE DESCRIPTION

2.2 Geology and Mineral Resources

.1 Geology (Continued)

development and subsequent vegetation development. Fracturing also appears to have affected river valley orientation, and may affect ground water flow.

Detailed surface mapping of the tract and surrounding area has not disclosed any significant faults. The nearest significant faults occur on the Sulphur Creek anticline about 2 miles northwest of the tract. Faults are also present on the Piceance Creek anticline approximately 3 miles north of the tract.

.2 Mineral Resources

Figure 2.8 shows estimated oil shale richness in the Mahogany and underlying R-6 Zones in relation to the estimated size and location of the planned in situ retorts. Figure 2.9 is a east-west stratigraphic cross section of the tract with various surface and sub-surface characteristics labeled.

An in-place shale oil resource of 2.5 billion barrels is estimated for tract acreage not restircted by various shaft and boundary pillars, safety regulations, design considerations, and boundary irregularities. Some 1.05 billion barrels is expected to be recovered using the currently proposed three-phase mining plan.

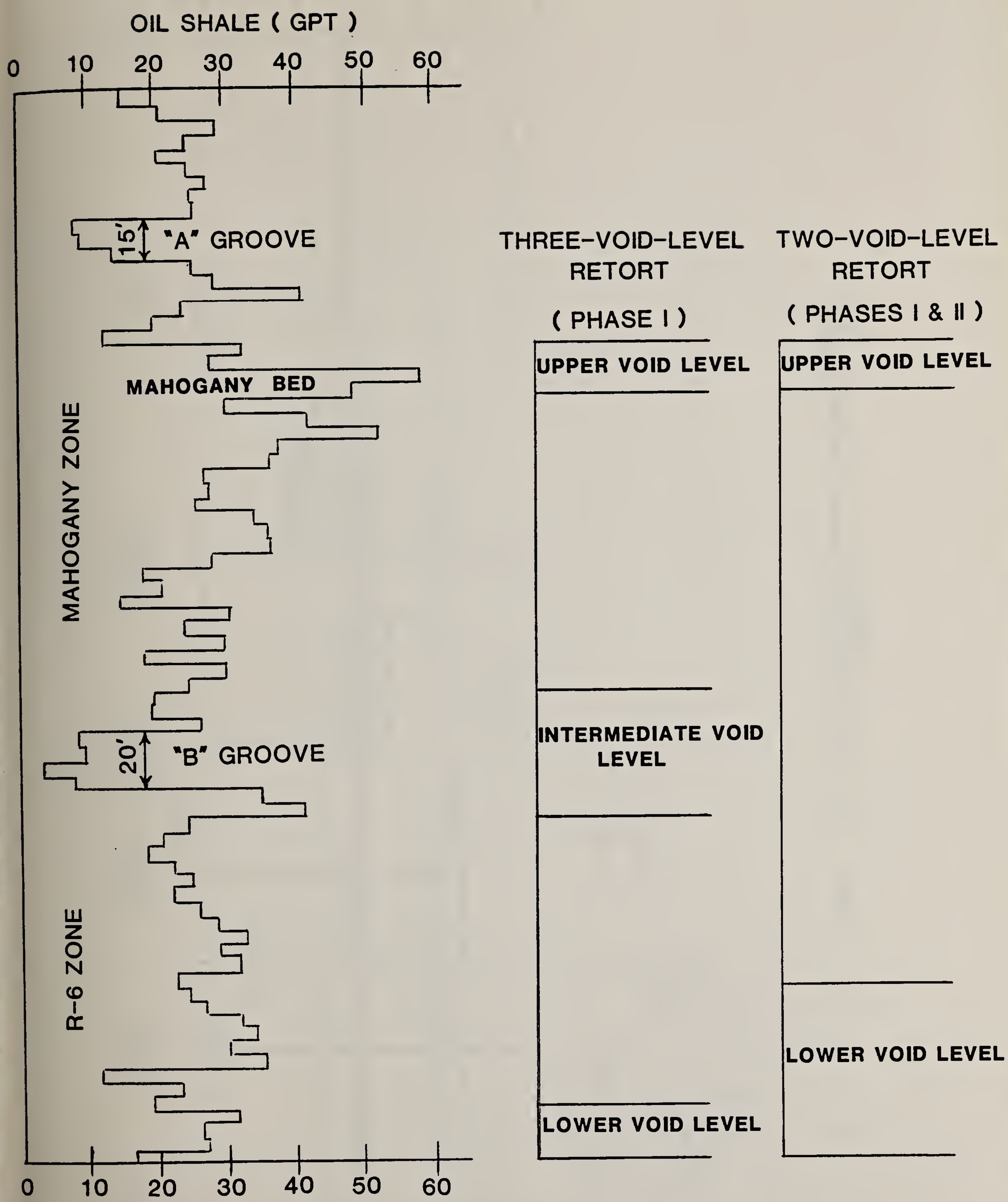


Figure 2.8 IN PLACE OIL SHALE GRADE THROUGH 290-FT MIS RETORT

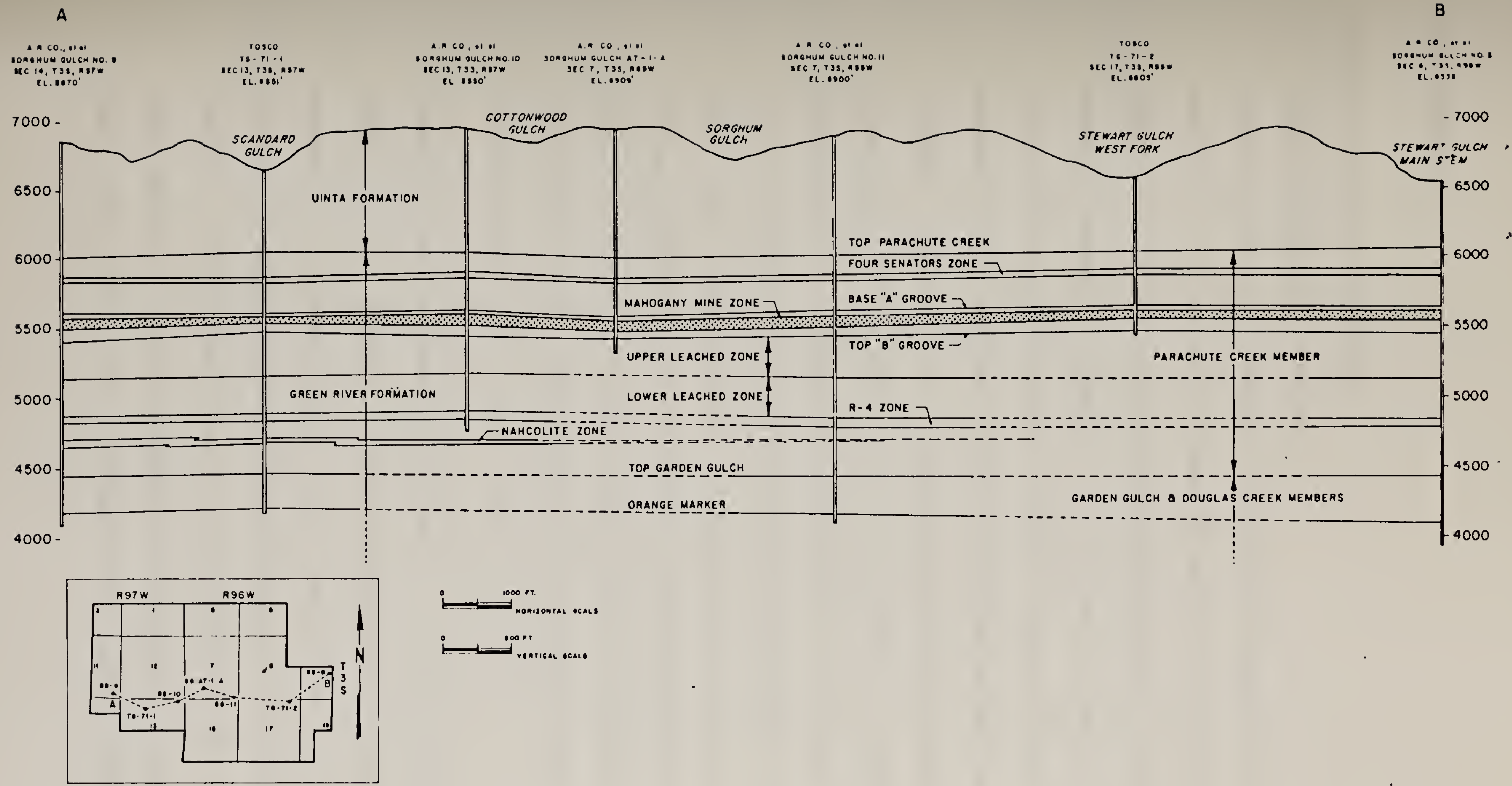


Figure 2.9 EAST-WEST STRATIGRAPHIC CROSS SECTION TRACT C-b

2.0 SITE DESCRIPTION

2.2 Geology and Mineral Resources

.2 Mineral Resources (Continued)

Both nahcolite and dawsonite are present beneath the tract. Nahcolite is occasionally found in nodule form within the Mahogany Zone, but in such small amounts that if affords no apparent commercial potential. The zone of greatest nahcolite concentration on the tract is found in the lower part of the Parachute Creek section, about 120 feet below the base of the R-4 Zone (Figure 2.10). This nahcolite-bearing interval is present only in the western half of the tract. An estimated 30,000,000 tons of nahcolite are present on the tract within the main nahcolite zone which occurs in moderately lean oil shale (i.e., shale that will average on the order of 20 GPT). The low concentration of nahcolite, plus the presence of lean shale, eliminates this zone as an interval of interest in the foreseeable future. Nahcolite is also present in small amounts in the R-4 Zone on the west side of the tract.

Dawsonite, an alumina-bearing mineral, is found throughout the Mahogany Zone. However, as the concentration of potentially recoverable alumina (Al_2O_3) in this part of the section averages less than 1 percent, dawsonite extraction is not economically feasible. Within the "lower oil shale zone" of the Parachute Creek section, there are numerous thin intervals (usually less than 10 feet thick) which average about 5 percent alumina.

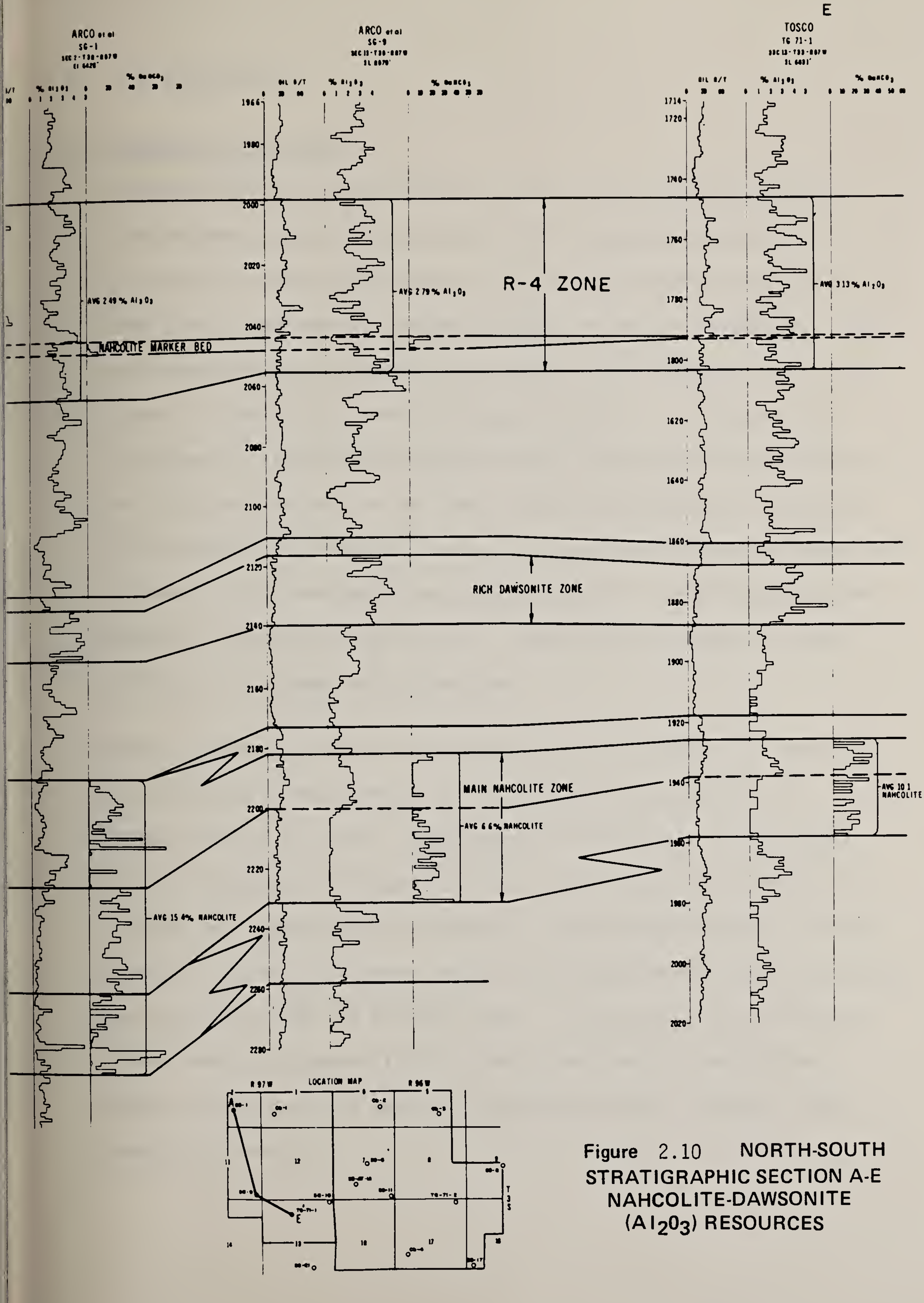


Figure 2.10 NORTH-SOUTH STRATIGRAPHIC SECTION A-E NAHCOLITE-DAWSONITE (Al_2O_3) RESOURCES

2.0 SITE DESCRIPTION

2.3 Atmospheric Conditions

Irregular terrain in the Piceance Basin greatly influences surface wind patterns, which, in turn, gives rise to both mechanically and thermally induced turbulence. Hourly average wind speeds range from 3 to 10 mph and are generally higher on the tract plateau. Gusts to 79 mph have been recorded at the meteorological tower on the tract plateau in the spring, when strongest winds occur. Wind speed and direction are typically influenced by both the synoptic-scale wind and the frictional effects of the land surface and temperature gradients. Wind direction on the tract plateau is predominantly from the south and southwest, as determined by the synoptic winds. The valley winds are typically channeled up valleys in a southeasterly direction or down valleys in a northwesterly direction.

Strong, outgoing terrestrial radiation during the night can cause rapid cooling of the surface air. This causes inversions that impede vertical air flow. Measurements of the variation in temperature at increasing altitudes (the lapse rate) can help determine the presence and intensity of an inversion. These measurements, to date, show that the fall and winter months tend toward more stable conditions, particularly during the daylight hours. In contrast, the spring and summer months are generally less stable, and tends to destabilze further during daylight hours as thermal turbulence increases with surface air heating.

2.0 SITE DESCRIPTION

2.3 Atmospheric Conditions

Precipitation, relative humidity, vertical temperature profiles, surface wind patterns, and wind speed are dependent on local topography. During the environmental baseline program, a maximum hourly temperature of 90°F was recorded (July 1975) on both the tract plateau and in the Piceance Creek Valley, which is 600 feet lower in elevation.

The minimum temperatures for the plateau and the valley were -29°F and -52°F, respectively, in January 1975. Substantial differences between minimum temperatures in the plateau and the valley are common, particularly in the colder fall and winter months because the topography encourages downslope drainage of colder air into lower-lying valleys. This topographical feature also results in more stable atmospheric conditions in the valleys and tends to restrict vertical air movement.

The higher plateaus in the area generally receive more precipitation than the valleys and lower-lying areas. The maximum monthly precipitation recorded on the tract was 1.2 inches in May 1975; during July 1975, 0.85 inches fell in the Piceance Creek Valley. Relative humidities ranged from 100 percent to a low of 8 percent. The average is 62 percent, but diurnal variations of 80 percent are common, particularly in the Piceance Creek Valley, where irrigation activities and large diurnal temperature variations cause large relative changes in humidity.

2.0 SITE DESCRIPTION

2.3 Atmospheric Conditions

.1 Air Quality

The Piceance Creek basin is largely undeveloped and substantially free from atmospheric pollution. However, air quality data indicate that this is not a completely accurate picture of the atmosphere in the immediate vicinity of the tract.

To determine the baseline, ambient air was monitored on the tract plateau and in the Piceance Creek Valley and analyzed for several different gaseous pollutants and particulates on a daily basis. Monthly averages of these data have shown ambient air concentrations for most of these gases to be near natural background levels. However, the data have occasionally indicated ambient air concentrations substantially greater than usual background concentrations. One explanation is that other man-made or natural sources in the vicinity sometimes cause increased concentrations.

Ambient air concentrations for particulates, though typically low, can vary over a wide range near the tract. These variations are primarily caused by fugitive dust stirred up by the frequent winds or, to a lesser extent, by human activity and automobile traffic.

Table 2.1 indicates existing background levels of critical pollutants and compares them with pertinent federal and

Table 2.1
COMPARISONS OF MAXIMUM BACKGROUND LEVELS WITH AMBIENT STANDARDS

Applicable Standard	Constituent	Averaging Time	Standard Limit (ug/m^3)	Maximum Reading (ug/m^3)	Station with Maximum Reading	Date of Maximum Reading
Colorado Ambient Air Quality Standards	Particulates	Annual	45	11.2	023	74 - 75
		24-hour	150	178	024	11/27/74
National Ambient Air Quality Standards						
Primary	SO_2	Annual	80	1.3	021 & 024	74 - 75
		24-hour	365	43.1	021	6/16/75
Secondary	SO_2	3-hour	1,300	87.7	023	12/21/74
Primary	NO_2	Annual	100	5.0	020	75 - 76
Primary	Particulates	Annual	75*	10.7	023	74 - 75
		24-hour	260	178	024	11/27/74
Secondary	Particulates	Annual	60*	10.7	023	74 - 75
		24-hour	150	178	024	11/27/74
Primary	NMHC	3-hour (6-9 AM)	160	2,596.6	023	6/27/76
Primary	CO	8-hour	10,000	4501.9	020	6/ 3/75
		1-hour	40,000	4650.9	020	6/ 4/75
Primary	Oxidant	1-hour	160	160.4	020	6/26/75

* Geometric Mean.

Source: Environmental Baseline Report, Vol. III, p. 159

2.0 SITE DESCRIPTION

2.3 Atmospheric Conditions

.1 Air Quality (Continued)

state standards. High particulate values are solely attributable to fugitive dust.

2.4 Hydrology

Tract C-b is located in the Upper Colorado River basin, which includes, as illustrated in Figure 2.11, the drainages of the Colorado River between Lee's Ferry, Arizona, and the Great Divide basin in south-central Wyoming, or approximately 109,500 square miles. The basin is divided into three subregions: Upper Main Stem, Green, and San Juan. The Upper Main Stem subregion includes the areas of oil shale deposits in the Piceance Creek basin (see Figure 2.12).

Stream flow from the Piceance Creek drainage basin is typical of those regions in which the primary source of stream flow is snowmelt. Precipitation from November through March is stored in snowpack at higher altitudes of the basin and becomes available for recharge and runoff as daily temperatures and solar radiation increases in the spring. Snowmelt produces a period of high stream flow, starting in March or April and continuing through June or July. Stream flow for the remainder of the year is maintained almost totally by groundwater discharge, which moves through the alluvium into the stream channels or appears as springs along the valley floors. Evapotranspiration rates are high during the summer, and most of the precipitation that occurs during this period is

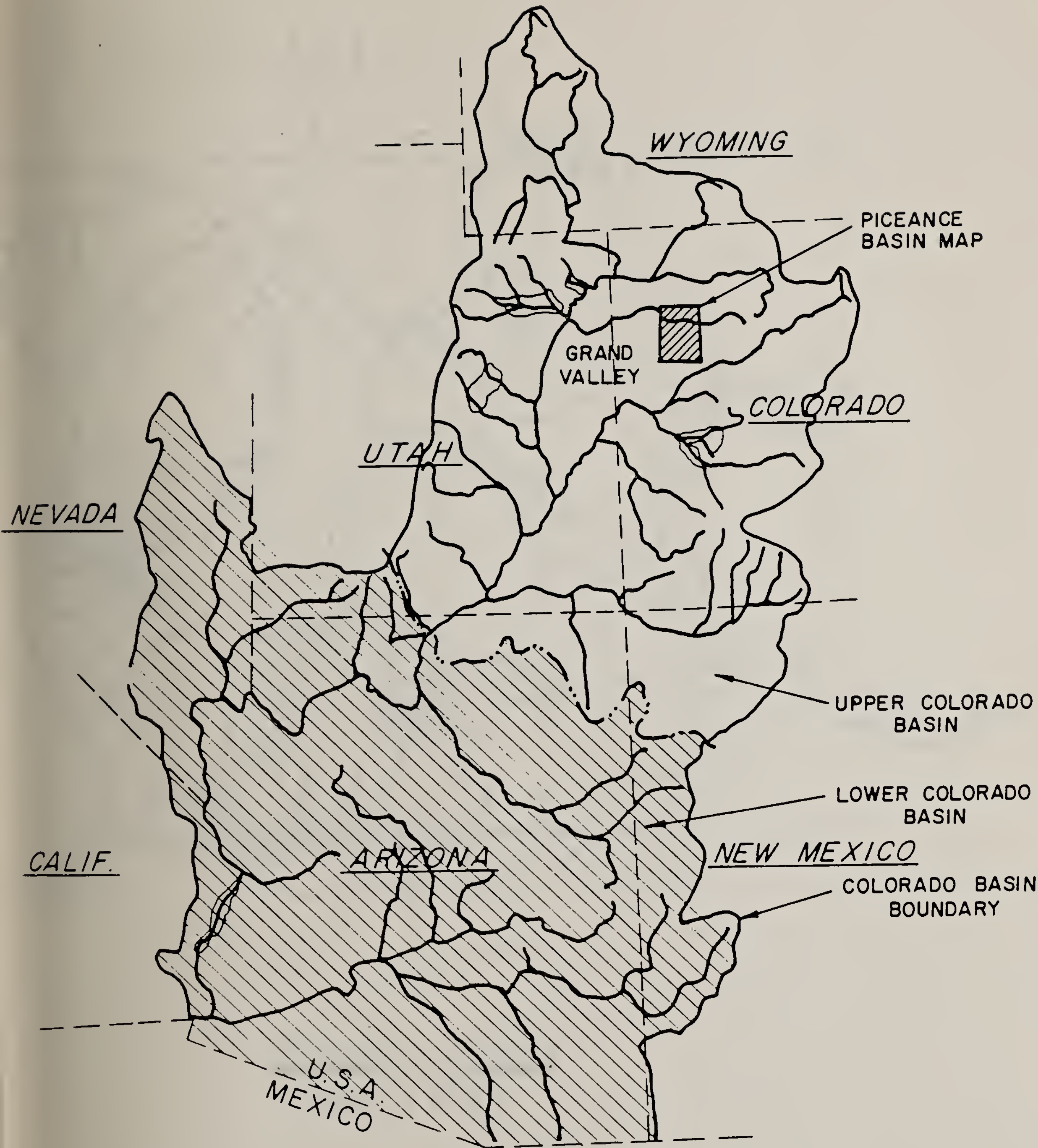


FIGURE 2.11 **COLORADO RIVER BASIN**

Source: "Detailed Development Plan and Related Materials": Ashland Oil, Inc. Shell Oil Co. Operator (1976)

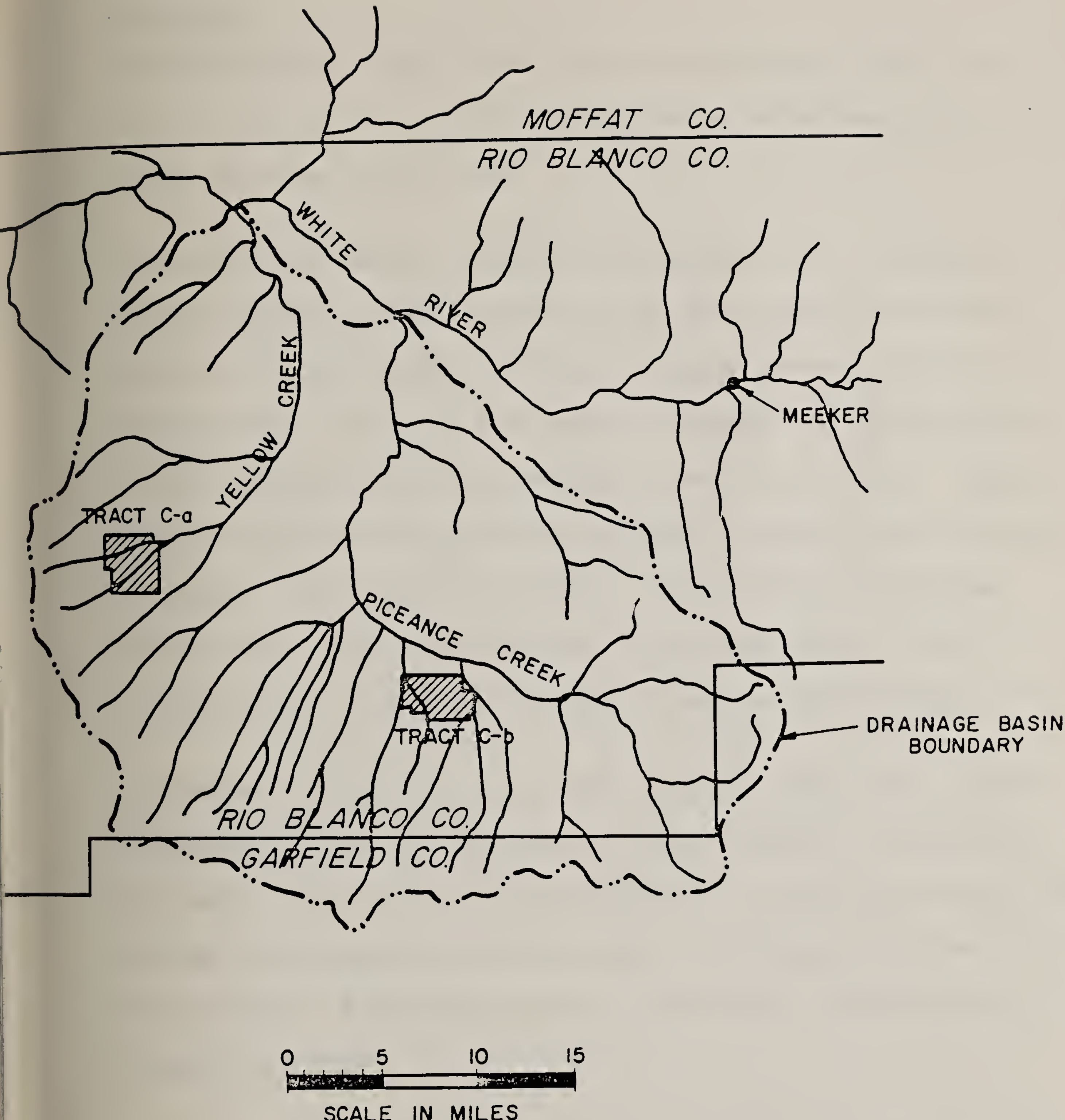


FIGURE 2.12 **PICEANCE CREEK BASIN AND TRACTS C-a AND C-b**

Source: "Detailed Development Plan and Related Materials": Ashland Oil, Inc. Shell Oil Co., Operator (1976)

2.4 Hydrology

evaportransipred. Only high-intensity thunderstorms, which are usually limited to a small area, produce any significant contributions to summer stream flow.

The largest stream near the tract is Piceance Creek. Piceance Creek originates in the vicintiy of the Grand Hogback Mountains, north of Rifle, Colorado, and flows west and northwest into the White River, 17 miles west of Meeker, Colorado. An average annual flow of 14,500 acre-feet was measured from Piceance Creek. Approximately 80 percent of the flow is believed to result from ground water discharge. At the mouth of Piceance Creek, the total dissolved solids (TDS) average 1,000 milligrams per liter (mg/L). Main constituents are magnesium, sodium, bicarbonate, and sulfate.

The White River flows into the Green River at Ouray, Utah, and the Green River flows into the Colorado River southwest of Moab, Utah. The White River has an average annual flow of 554,000 acre-feet, with 439 mg/L TDS measured near Watson, Utah. Average annual flow of the Green River is 4,187,000 acre-feet, with 456 mg/L TDS measured at Green River, Utah.

In the vicinity of the tract, two major perennial streams, Willow Creek and Stewart Creek, flow into Piceance Creek. Drainages on the tract are also tributaries to Piceance Creek. Willow Creek borders on the tract to the west (see Figure 2.13). Several large springs south of the tract provide significant flows to this creek; some

2.4 Hydrology

water enters the alluvium along the creek bottom and is lost from the surface system. Willow Creek can be termed perennial throughout most of its length, from the headwater drainage area of East Fork Willow Creek to its mouth near the tract.

A major ephemeral tributary to Willow Creek is Scandard Gulch, which passes through the western portion of the tract; it is generally dry. The Stewart Gulch drainage system is located along the eastern edge of the tract and also extends south of the tract. Most of the channels are ephemeral and generally dry. Perennial flows are found in the main stem of Stewart Gulch and West Fork Stewart Gulch. Flow in the main stem originates from a seepage area approximately 1 mile upstream from the junction with the West Fork. Other drainages on the tract include Sorghum Gulch and Cottonwood Gulch. All of these ephemeral tributaries to Piceance Creek are typically dry. Flow occurs only from snowmelt or local thunderstorms.

2.5 Biotic Communities

.1 Flora

Approximately 175 species of vascular plants in the tract area have been identified to date. These species are characteristic of the Rocky Mountain and Great Basin floristic regions. Composites, grasses, mustards and legumes are the most commonly encountered plants. No endangered or threatened plant species have been observed within the study area.

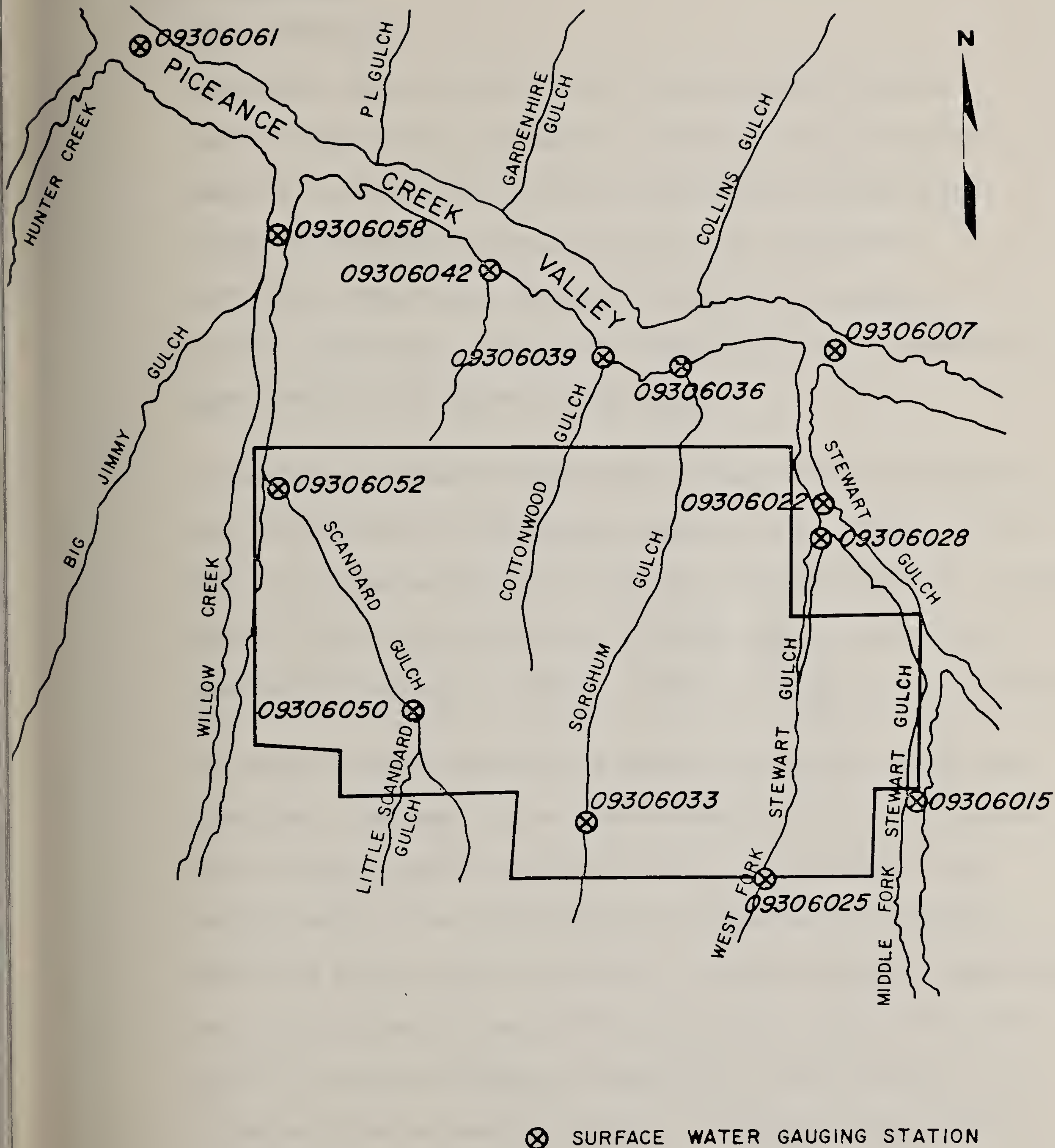


FIGURE 2.13 SECTION OF THE PICEANCE CREEK DRAINAGE BASIN

Source: "Detailed Development Plan and Related Materials": Ashland Oil, Inc. Shell Oil Co., Operator (1976)

2.5 Biotic Communities

.1 Flora (Continued)

Vegetation community types include pinyon-juniper woodlands, chained pinyon-juniper rangelands, upland and valley sagebrush communities, Douglas-fir forests, mixed mountain shrublands, bunchgrass communities, Great Basin wild rye communities, rabbitbrush communities, greasewood communities, marshes, riparian communities, agricultural fields, annual wild communities, aspen woodlands and mountain grasslands.

Chaining done by the BLM has produced a rangeland characterized by many fallen trees on a shrubland vegetation type. Because of this, herbs and shrubs on the tract tend to be more abundant than in neighboring pinyon-juniper woodlands. Dominant species include big sagebrush, bitterbrush, snowberry, mountain mahogany, and serviceberr

The pinyon-juniper woodlands are the most widespread in the tract study area. Dominant species include pinyon pine and Utah juniper. Shrub and herb layers tend to be sparse. Big sagebrush, with heights over six feet, occur mostly on ridges and in clearings within the pinyon-juniper woodlands, in upland sagebrush communities, and in the bottoms of the smaller gulches and valleys. The herb layer in the upland sagebrush communities is quite diverse. It is characterized by numerous species, in contrast to the valley sagebrush communities where the herb layer is sparse and characterized by few species.

2.5 Biotic Communities

.1 Flora (Continued)

The mixed mountain shrublands form a nearly continuous layer on north-facing slopes. The herb layer in this community includes numerous species which do not occur elsewhere within the study area.

The agricultural fields in the tract vicintiy are located along Piceance Creek. Irrigated meadows are used for hay production in the summer and cattle grazing in the winter. During the fall and spring, these meadows are used by the mule deer population as feeding areas.

In the past, industrial and ranching activities on the tract have produced conditions which allowed the development of widely distributed annual weed communities such as cheatgrass, tumble mustard, white pigweed, goosefoot and Russian thistle. Also, agricultural activities have, to a limited extent, resulted in the growth of rabbitbrush communities on the flood plains of major drainages, where the community had been primarily valley sagebrush.

In addition to the vegetation types which occur within the tract study area, there are three other major plant communities along the off-tract utility and pipeline corridors. Aspen woodlands occur at the highest elevations along the corridor route and are restricted to northfacing slopes. The herb layer

2.0 SITE DESCRIPTION

2.5 Biotic Communities

.1 Flora (Continued)

in the higher elevations is well developed and includes many species characteristic of higher-elevation plant communities. Mountain grasslands occur on windswept hilltops and ridges at the upper end of the corridor route, and few shrubs occur in this community.

.2 Fauna

The tract supports three distinct animal groups. The first group includes the small mammal populations and those bird species which are present in the area for their entire life cycle The second group primarily consists of mule deer, migratory birds, wintering birds, breeding birds and cattle, all of which make use of the area during specific periods of each year. The third group includes medium-sized mammals and predators, which utilize the tract area as part of their broad ranges.

Some animals occur selectively on the tract, in restricted habitat types. For example, voles are found primarily in meadow habitats; and the red-eyed vireo has been seen only in the limited cottonwood habitat of Cottonwood Gulch. Other species such as deer mice are found almost universally in all habitat types. A greater species diversity of rodents is found in the chained pinyon-juniper type than in the unchained type, presumably as a result of the increased habitat provided by the uprooted trees and the increased understory growth.

2.5 Biotic Communities

.2 Fauna (Continued)

During the period when mule deer utilize the tract area, they seem to make use of all available habitats. Greatest use is made of the chained pinyon-juniper and plateau sagebrush vegetation types during most of the winter, and the least use of the valley sagebrush. Hay meadows along Piceance and Willow Creeks are used heavily in early fall and spring. As the winter progresses, the south-facing slopes become increasingly important as crusted snow builds up and makes access to food difficult. At these times, south-facing slopes are free of snow and are heavily used by the mule deer.

While no big game species other than mule deer have been found on the tract, a few elk are found in the vicintiy south of the tract. Winter and summer deer ranges appear to overlap to the south with approximately equal usage of adjacent ridges.

The small and medium-sized mammals which occur on the tract serve as prey for predatory birds and carnivorous mammals such as the coyote. Important prey species include the voles, the cottontail and (as carrion) mule deer. Coyotes are relatively abundant in the tract as evidenced by the results of standardized census techniques used throughout Colorado and the West. Bobcats inhabit cliff areas on the tract and to the south.

2.0 SITE DESCRIPTION

2.5 Biotic Communities

.2 Fauna (Continued)

The tract is located in nesting territory for mourning doves. South of the tract also includes areas of possible sage grouse nesting sites. No other game birds are known to inhabit the area. Raptor nests are found on the cliffs. Identified nesting raptor species include red-tailed hawks, great-horned owls and common ravens. Golden eagles are also seen in the area.

With regard to threatened or endangered species, in the past praire falcons have been seen in the vicinity but none have been seen on the tract. Bald eagles winter on the White River drainage and are occasionally seen near the tract in the winter. Sandhill cranes have been seen near the tract but are merely migrating through to their winter area.

.3 Aquatics

Aquatic habitats in the area of the tract are sparse. Most streambeds in this area contain intermittent streams, which are dry most of the year. The few existing ponds are spring-fed, existing primarily as the result of man-made dams. Some species of game fish (brook trout, a few rainbow trout and a few brown trout) are found in the creeks. Spawning occurs in Piceance Creek, in the vicintiy of lower Stewart Lake, and in the lower-most reaches of Willow Creek. The most abundant fish species are nongame species such as speckled dace and mountain suckers.

2.0 SITE DESCRIPTION

2.5 Biotic Communities

.3 Aquatics (Continued)

Water quality fluctuates in the creeks thorughout the year, and is generally correlated with the amount of stream flow and with the presence or absence of cattle in the immediate area.

3.0 PROJECT DEVELOPMENT SCHEDULES

3.1 Master Engineering, Procurement and Construction Schedule

The Master Development Schedule shown in figure 3.1 presents the engineering, procurement and construction progress planned for Tract C-b. The schedule represents a time span from the third quarter of 1980 through plant shutdown, and includes activities for mine and shaft development, on and off-site surface development, and site reclamation.

By the third quarter of 1980, all activities necessary for major shaft sinking, site development, major equipment procurement and final detailed engineering design and commenced. The shafts under construction include the Ventilation/Escape, Service, and Production shafts. All three shafts have been completed to the ignition level (over 1,100 feet). Site development consists of general clearing around the shaft sinking operations, initial shaft headframe construction and the helipad construction. Both procurement and engineering design functions have begun full scale operations and are supplying the necessary drawings and equipment to support the construction effort.

The milestone dates referenced on the Master Schedule are:

Ventilation/Escape Shaft Equipped and Fully Operational - Dec. 1981

Production Shaft Equipped and Fully Operational - May 1982

Service Shaft Equipped and Fully Operational - Sept. 1982

Ignition of First In Situ Retort - May 1985

Begin Phase II Development - Early 1988

Full In Situ Retort Oil Production - August 1988

3.0 PROJECT DEVELOPMENT SCHEDULES

3.1 Master Engineering, Procurement and Construction Schedule

Surface Retort Facility Completed - July 1989

Begin Phase III Development - Mid 1991

End of First Commercial Phase - 2028

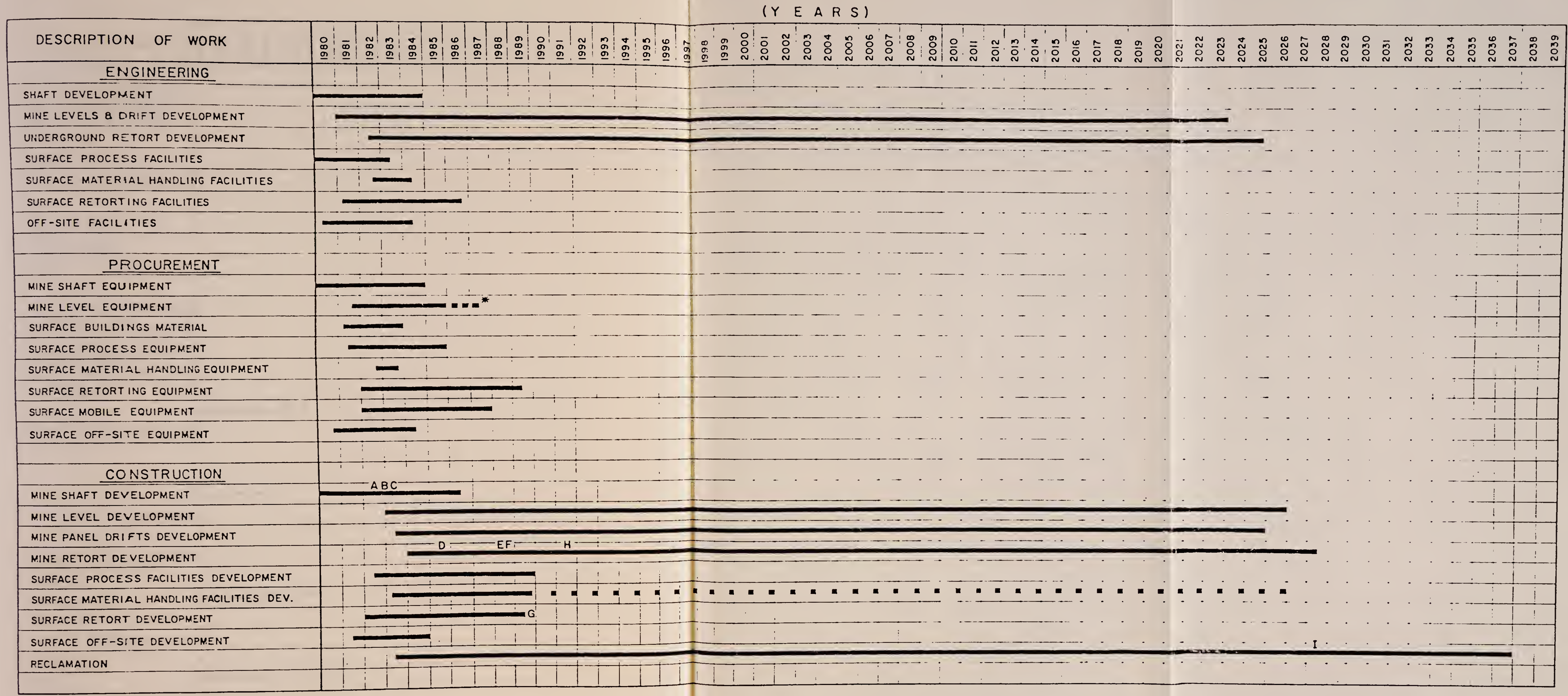
Major events shown on the Master Schedule are further defined in the following sections and schedules.

3.2. Mine Development Schedule

The mine development schedule, Figure 3.2, displays construction sequences for developing shafts, in situ retorts, and mine support facilities. A plot plan depicting these shafts and facilities is shown on drawing EM-131. The retort burning schedule for all three phases is presented to illustrate time relationships between retort development and retort burning. As shown, Phase II retort development begins nearly two years prior to the completion of Phase I retort burning. Similarly, development of Phase III retorts commences almost two years before all Phase II retorts are depleted. This two year difference in retort development and burning is scheduled to maintain full oil production levels and appropriately utilize personnel.

The Production, Service, and V/E Shafts are sunk prior to the remaining four shafts to permit mine development activities to commence in early 1983. Exhaust Shaft No. 1, the retort offgas shaft, and air intake shaft are sunk and fully equipped prior to initial retort ignition in mid-1985. Exhaust Shaft No. 2 will be completed in 1986 as further in situ retort development increases ventilation requirements.

MASTER ENGINEERING, PROCUREMENT AND CONSTRUCTION DEVELOPMENT SCHEDULE



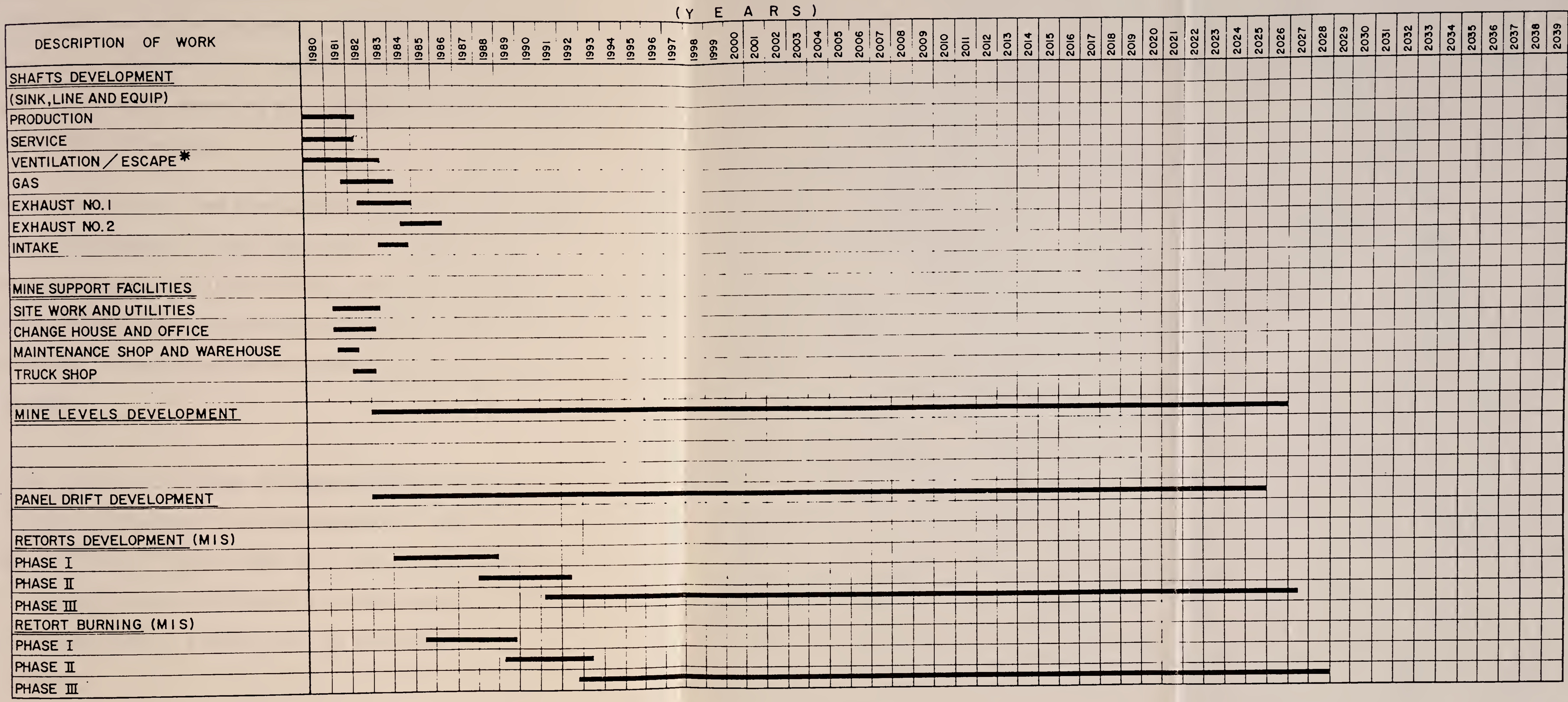
* IS A CONTINUOUS ACTIVITY THROUGH MINE DEVELOPMENT

MILESTONES:

A. VENTILATION / ESCAPE SHAFT EQUIPPED AND FULLY OPERATIONAL.
B. PRODUCTION SHAFT EQUIPPED AND FULLY OPERATIONAL.
C. SERVICE SHAFT " " " "
D. IGNITE FIRST IN SITU RETORT.
E. BEGIN PHASE II DEVELOPMENT.
F. FULL IN SITU RETORT OIL PRODUCTION.
G. SURFACE RETORT FACILITIES COMPLETED.
H. BEGIN PHASE III DEVELOPMENT.
I. END OF FIRST COMMERCIAL PHASE.

Figure 3.1 MASTER ENGINEERING, PROCUREMENT AND CONSTRUCTION SCHEDULE

MINE DEVELOPMENT SCHEDULE



* V/E Shaft sinking complete Sept. 1981

Interim operation thru Dec. 1982

Recovery and Equipping thru June 1983

Station development from Prod. and Service Shafts will be initiated July 1982

Details of Interim operation are given in Section 8.4.4

Figure 3.2 MINE DEVELOPMENT SCHEDULE

3.0 PROJECT DEVELOPMENT SCHEDULES

3.3 Surface Retorting and Process Facilities Construction Schedule

Figure 3.3 depicts the construction schedule for the Surface Process Facilities (SPF) and the surface retorts. As shown, SPF Train No. 1 is built prior to the other units for testing purposes. The other four trains are constructed according to a staggered schedule to meet underground retorting production.

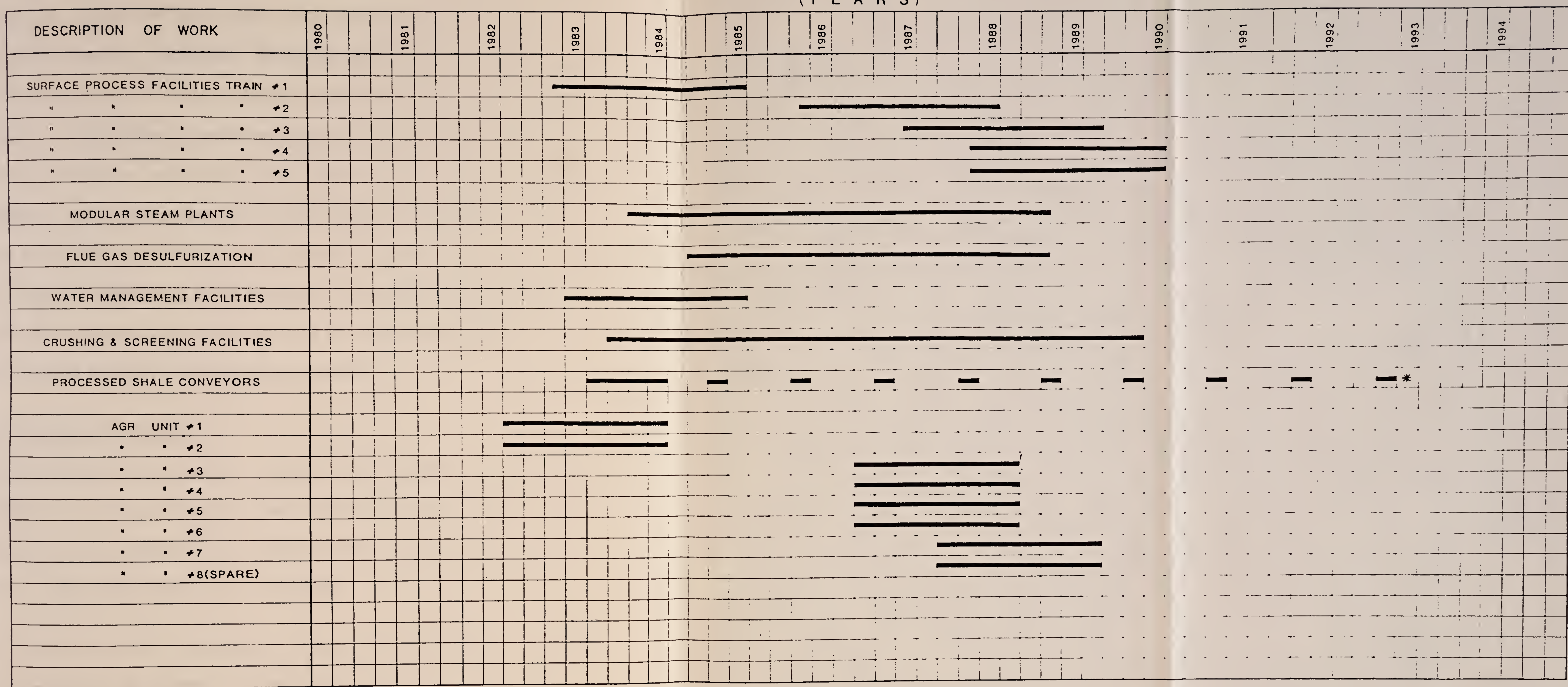
Construction of the modular steam plants and equipment for flue gas desulfurization are scheduled to meet the needs of the five SPF trains. Water management facilities will be available to support retort ignition demands, and the crushing and screening facilities will be constructed to serve the surface retorts as they go on-line from 1984 to 1989.

Processed shale conveyors are shown as dashed lines in Figure 3.3 to represent its periodic movement during development of the processed shale stockpile. Surface retorts (AGR) No. 1 and 2, also shown in Figure 3.3, are constructed simultaneously so that one may be operational and the other used as a spare prior to start-up of the remaining retorts.

SURFACE RETORTING & PROCESS FACILITIES

DEVELOPMENT SCHEDULE

(Y E A R S)



* CONTINUOUS ACTIVITY THROUGH MINE DEVELOPMENT

Figure 3.3 SURFACE RETORTING & PROCESS FACILITIES CONSTRUCTION SCHEDULE

3.0 PROJECT DEVELOPMENT SCHEDULES

3.4 Off-Site Construction Schedule

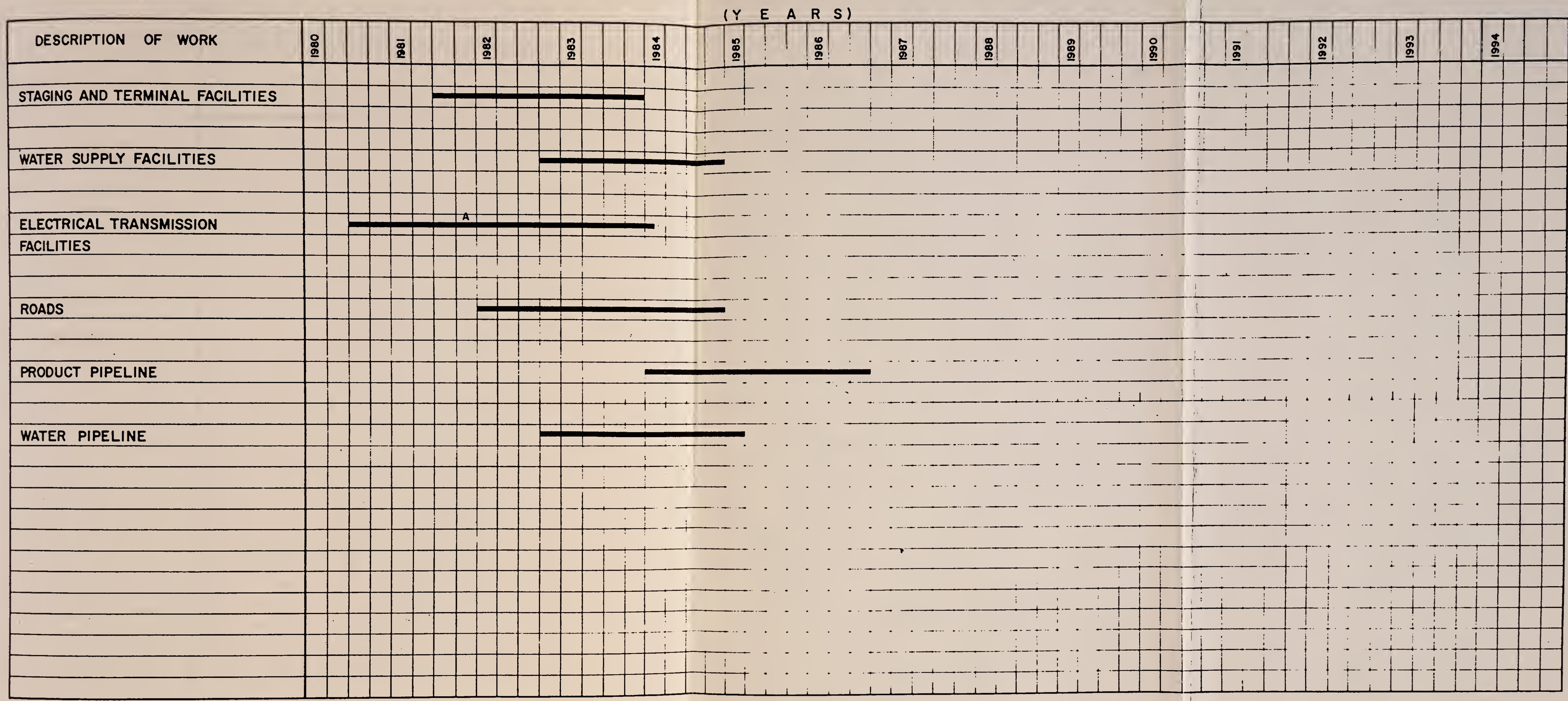
Construction work scheduled outside Tract C-b boundaries is presented in Figure 3.4. These off-site facilities provide support functions (equipment deliveries, byproduct shipping, power, etc.) to the main plant and, therefore, will be constructed during the early stages of development. Significant events on the off-site schedule include construction of water and product oil pipelines to meet production requirements, which are expected to peak late in the 1980s. The location and ownership of such facilities is undecided at this time and the required approval, from private land owners and/or government agencies, to construct these facilities will be obtained prior to starting any off-site construction effort.

3.5 Surface Disruption Schedule

The surface disruption schedule, Figure 3.5, represents the estimated total number of acres of surface land disturbed due to shaft and mine development, road construction, construction of the surface process facilities, and shale and topsoil storage.

Raw and processed shale stockpiles, along with the topsoil stockpile, account for nearly 81 percent of the total 2,027 acres disturbed. Processed shale disposal will affect nearly 1,346 acres, or approximately 66 percent of the total acreage disturbed. As shown on the schedule, surface disruption ceases in 2017, although mine development activities continue to 2028 and reclamation activities are not fully completed until 2038. This halt in surface disruption is attributed to the processed shale disposal area growing in height rather than expanding outward.

OFF-SITE CONSTRUCTION SCHEDULE



MILESTONE:

A. PERMANENT POWER AVAILABLE

Figure 3.4 OFF-SITE CONSTRUCTION SCHEDULE

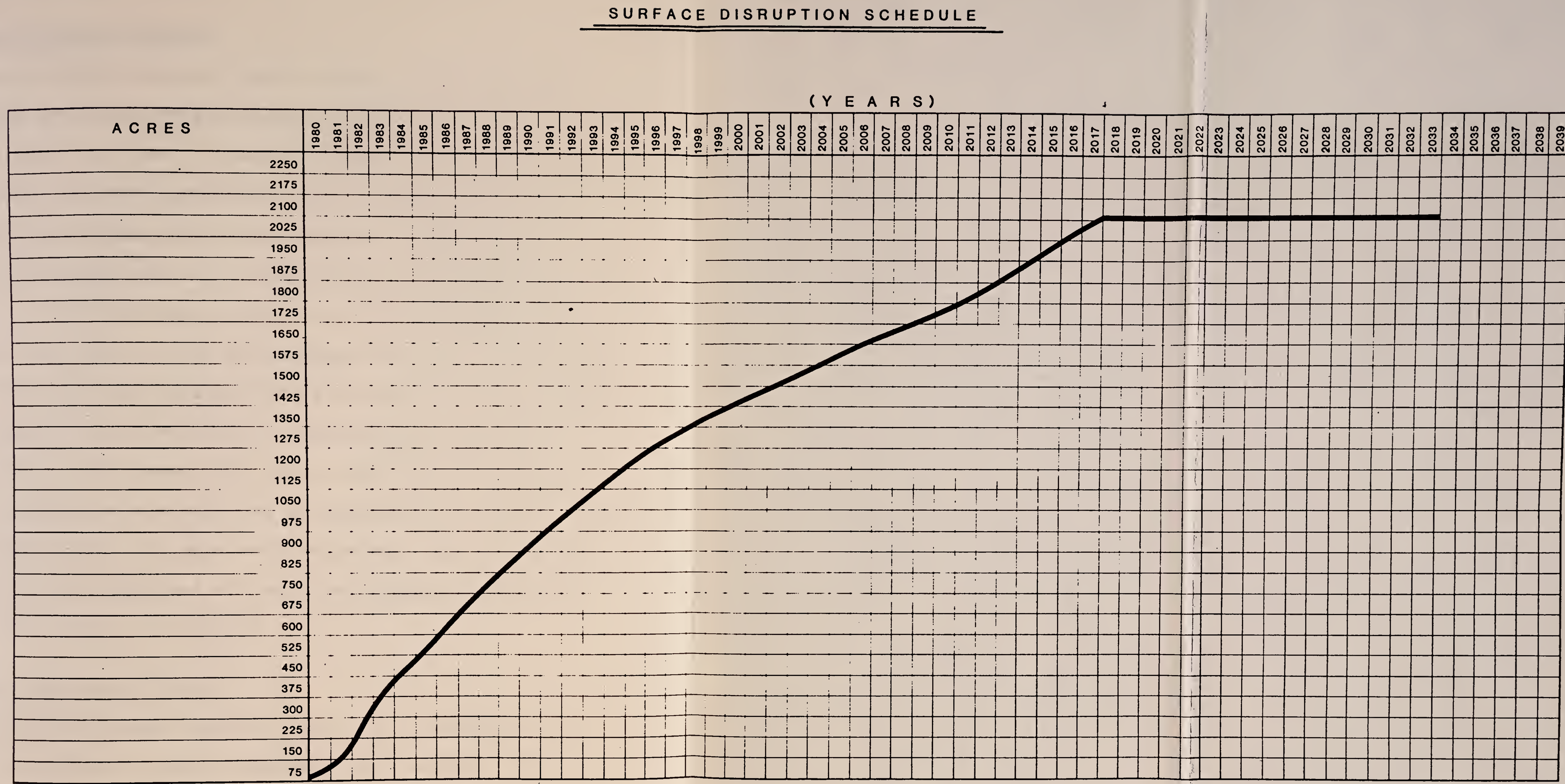


Figure 3.5 SURFACE DISRUPTION SCHEDULE

3.6 Surface Reclamation Schedule

Figure 3.6 displays the stabilization schedule for the raw shale stockpile and reclamation activities for the processed shale disposal area in addition to other reclamation projects. The schedule shows maintenance activities commencing on the raw shale stockpile for surface stabilization and other environmental reasons in mid-1983, and continuing until the pile is depleted (by surface retorting) and the area is fully reclaimed. Reclamation of the processed shale disposal area begins in 1987 and continues into 2033. Before final reclamation and tract abandonment, CB will determine whether renewed development of lower zone shales is technically and economically practicable. This schedule also shows a time frame for removing major equipment and buildings, and the expected mine closure duration, which begins after a two year cool-down period. Upon termination of the lease, site abandonment will occur on a schedule in accordance with lease sections 28 through 32.

3.7 Manpower Requirement Schedule

The manpower requirement schedule, Figure 3.7, is submitted in the form of a histogram in yearly increments. Each increment is further divided into major development categories in order to permit a detailed manpower analysis. The manpower histogram includes all direct labor required for total project develoment, construction, operation and final plant shutdown. As shown in the figure, manpower requirements drop nearly 18 percent during the Phase I to Phase II transition period (1990-1992) due to changes in retort design.

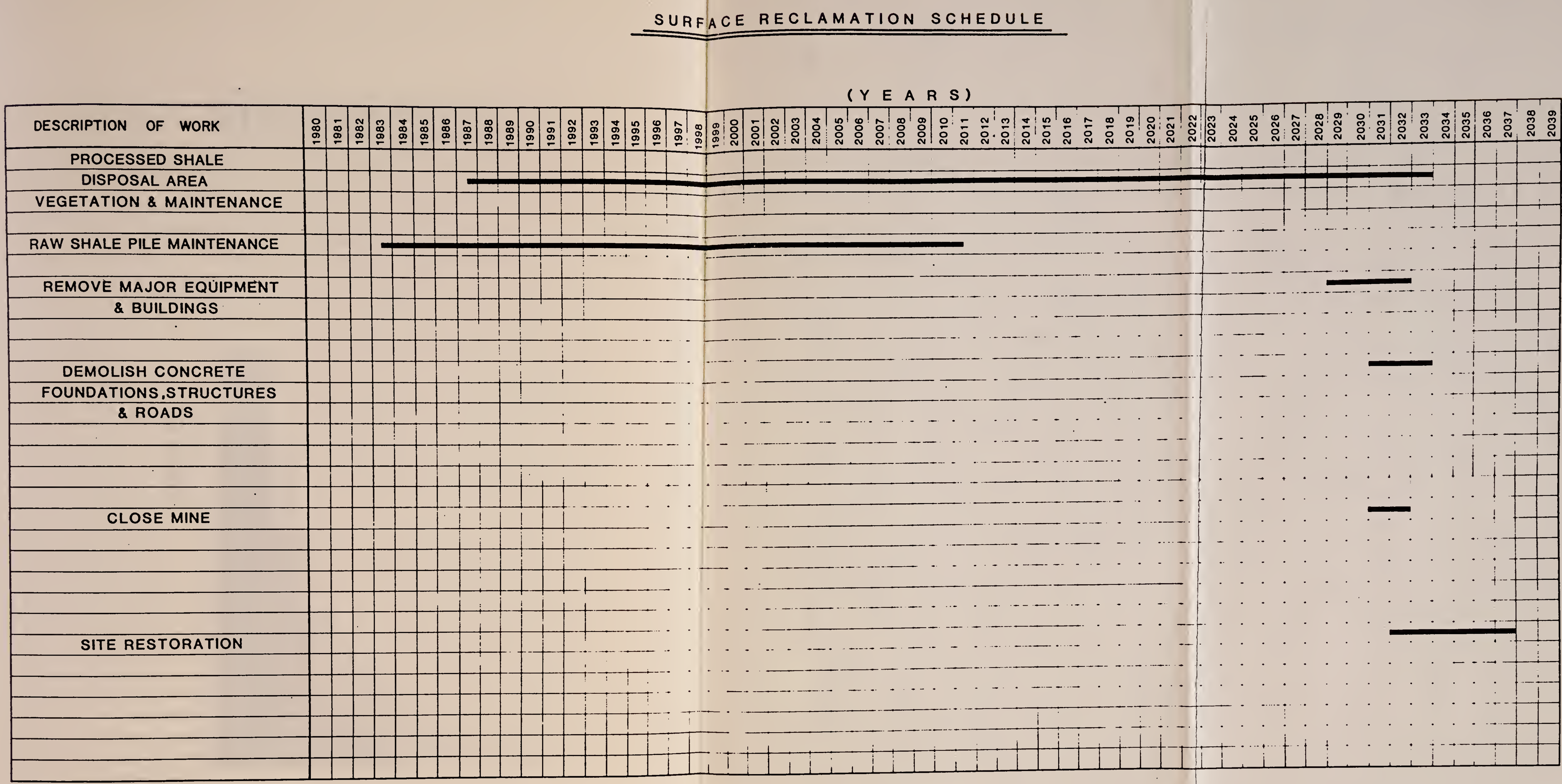


Figure 3.6 SURFACE RECLAMATION SCHEDULE

MANPOWER REQUIREMENT SCHEDULE

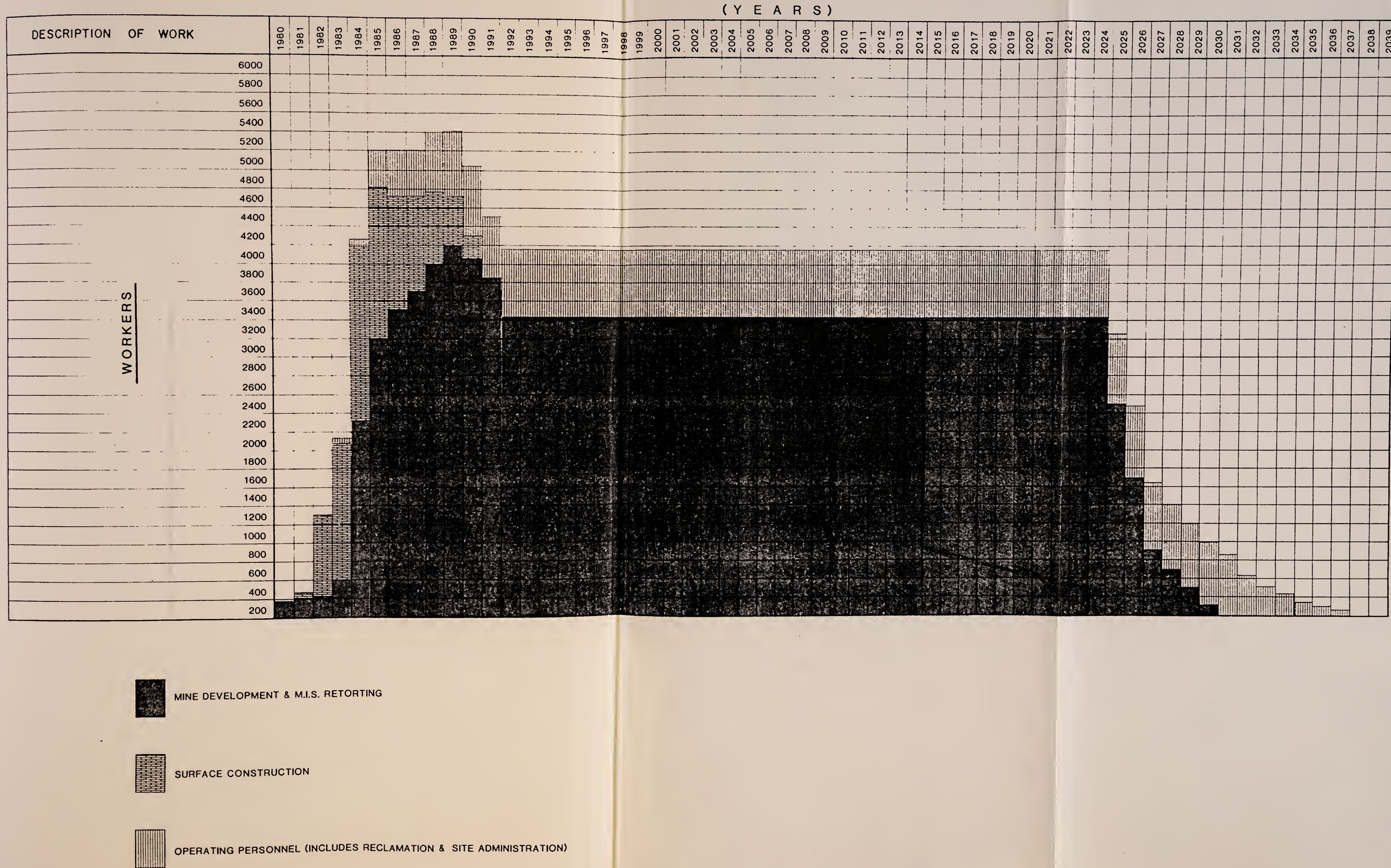


Figure 3.7 MANPOWER REQUIREMENT SCHEDULE

4.0 MINE DEVELOPMENT PLAN

4.1 Introduction

A new multiphase mining plan for the Cathedral Bluffs Oil Shale Project is presented here for the purpose of revising the Detailed Development Plant (DDP) for Federal Oil Shale Lease Tract C-b. This new plan involves significant changes in the design, layout, and operation of the underground oil shale mine and its integral shale oil recovery system. These and other pertinent features of the plan are covered in detail for review and approval by the Deputy Conservation Manager - Oil Shale.

The original DDP called for conventional underground mining and surface retorting of only the richest oil shale strata in the Mahogany Zone. This original plan later was modified to provide for the exclusive use of a Modified In Situ (MIS) process of underground mining and retorting for shale oil recovery from a 310-ft stratigraphic section that included most of the Mahogany and the underlying R-6 Zones. Initial mine development under the modified plan started in 1978 and currently is in progress.

The modified DDP was based on the MIS technology then developed by Occidental Petroleum Corporation at its Logan Wash experimental mine near Debeque, Colorado. Continued research and develpment at Logan Wash not only has increased overall knowledge of the MIS process but also has resulted in a variety of technological advances. Optimizinq mine and retort design to reflect this latest experience and technology would be most feasible during the initial stage of mine development.

4.0 MINE DEVELOPMENT PLAN

4.1 Introduction

Revisions in the modified DDP also will be required as a reslt of the mine being classed gassy by the Mine Safety and Health Administration late in 1979. An oil shale mine once so classified must be operated under the Federal health and safety standards for gassy metal and non-metallic underground mines. Compliance with these standards involves significant changes in design and layout, operating procedures, and equipment and material selection.

The desired technical improvement in the MIS retorts, together with the changes required for gassy mine operations, entail virtually a complete redesign of the underground mine as earlier envisioned. Both resource recovery and economic viability of the project also will be enhanced by the now-planned supplemental surface retorting of the raw shale generated by the extensive underground development for the MIS process. Implementation of this option will significantly enlarge and restructure the relatively modest surface facilities orginally required.

.1 Three-Phase Mining Plan

The now proposed three-phase mining plan for the lease tract would apply the Oxy MIS System to a 290-ft stratigraphic section of the Green River Formation lying some 1,200 feet below the surface. This oil shale horizon includes most of the Mahogany and R-6 Zones, and essentially is the same as considered in the earlier modification of the DDP. Its shale oil content

4.0 MINE DEVELOPMENT PLAN

4.1 Introduction

.1 Three-Phase Mining Plan (Continued)

ranges from as little as 3 to as much as 57 gallons per ton (GPT) but averages 27 GPT over the full section. Figure 4.1 shows the stratigraphy and grade of the oil shale in the mining horizon.

The now planned step-by-step phasing of operations will permit starting the project with the most conservative, dependable, and well documented retort design available; the eventual change to larger and more cost-efficient retorts; and the ultimate transition to thinner retort pillars for greater resource recovery with limited, if any, surface subsidence. Such transition would increase MIS shale oil production from this mining horizon by some 160 to 200 million barrels.

Retorts will be laid out in east-west rows or clusters several of which will be combined into panels to permit an orderly and systematic sequence of mining. Panels will be separated by continuous 300-ft-wide pillars that also contain the overlying main panel access drifts of each development level. Mine development over the full tract will consist of 23 such mining panels of various sizes containing an aggregate of 1,805 Phase I, II, and III retorts.

All retorts will have a common height equal to the full 290-ft thickness of the stratigraphic interval selected for MIS

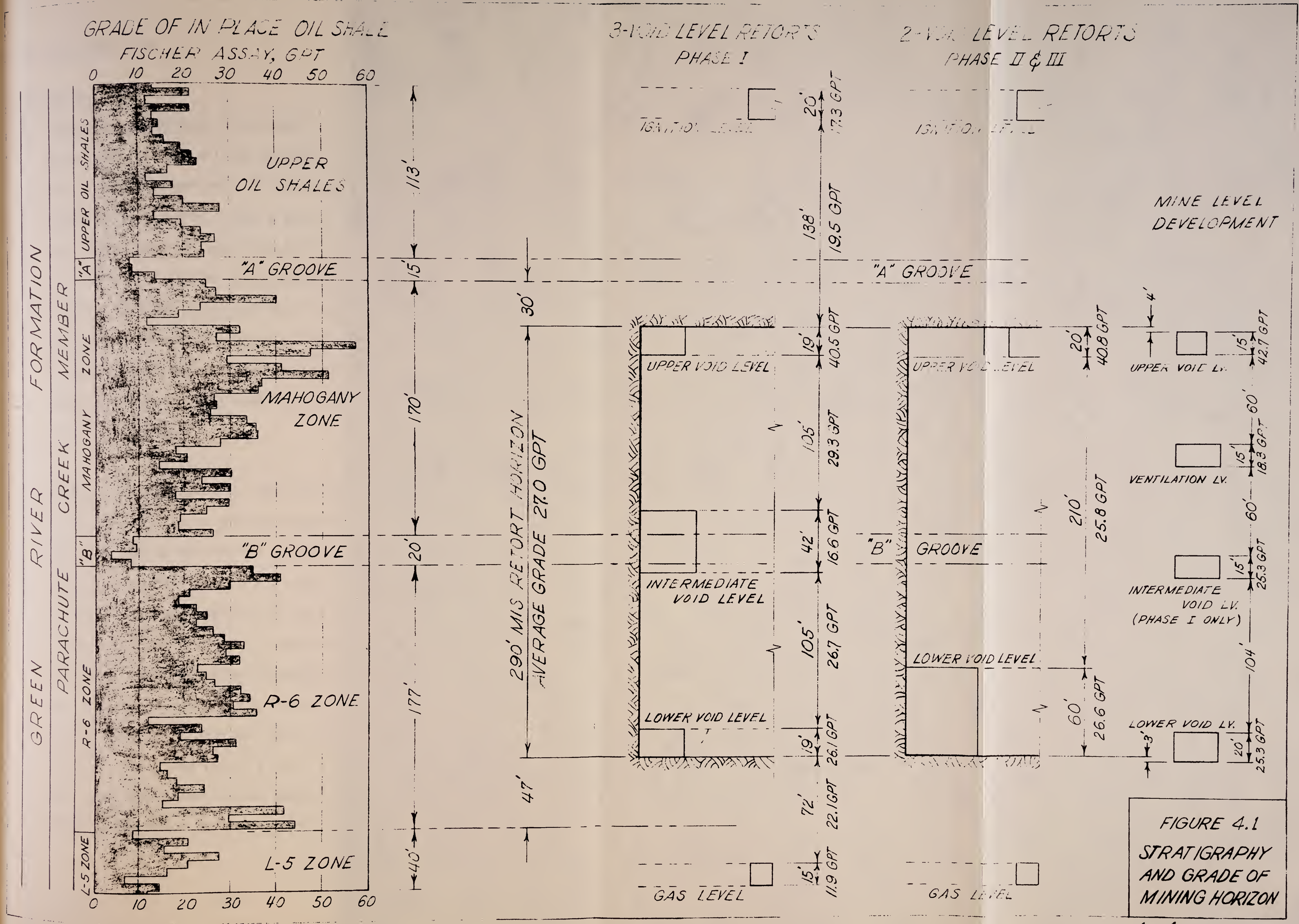


FIGURE 4.1
STRATIGRAPHY AND GRADE OF MINING HORIZON

4.0 MINE DEVELOPMENT PLAN

4.1 Introduction

.1 Three-Phase Mining Plan (Continued)

development, and all will be excavated for a common rubble void volume of 23 percent. All will have the same vertical burning rate of nearly 1 foot a day and a common life of 293 days. The theoretical retorting efficiency, or recovery, of 65 percent of Fischer Assay also will be the same for all retorts. Only the cross sectional area of the retorts, the number of their void development levels, and the size of the pillars between them will vary with the phase. Details of retort development, rubblization, operation, and production are covered in Section 4.5.

Phase I. The horizontally rubblized three-void-level retorts of Phase I will have a 165-foot-square cross sectional area, or about the same as the largely successful experimental Retort 6 at Logan Wash after which their design is patterned. These 225 retorts will be confined to four adjacent mining panels of 8 to 10 six-retort clusters each located at the approximate center of the tract. Subsidence from overburden loading of the retort rubble column is not expected owing to their static, or hard-pillar, design that provides 50-ft pillars between retorts within a cluster and 150-ft pillars between adjoining clusters. Mine level development to the Phase I retort area will start early in 1983 after the main shafts are fully operational, and

4.0 MINE DEVELOPMENT PLAN

4.1 Introduction

.1 Three-Phase Mining Plan (Continued)

the first retort will be ignited in mid-1985. Over its life, each of these smaller retorts is projected to yield a total of about 169,600 barrels of shale oil at an average rate of 579 barrels per day (BPD). Some 96 such retorts in 16 clusters must be burning when full MIS production of some 55,600 BPD is reached in mid-1988. The last of the Phase I retorts will be burned out in late 1989.

Phase II. The Phase II retorts will have a 165-ft by 380-ft rectangular cross section that is equivalent to a pair of smaller square retorts plus their intervening pillar. The 202 Phase II retorts will be confined to eight mining panels which comprise up to ten 3-retort clusters each and are laid out between the central retort area of Phase I and the north or south boundary of the tract. These larger retorts will be horizontally rubblized from only two void levels. They will have the same static design and the same size of pillars as the smaller retorts. In order to maintain full production, development of the Phase II retorts must begin early+in 1988 or nearly two years before the final Phase I retorts are depleted. Over their full life, each of the larger retorts is expected to yield a total of about 372,000 barrels of shale oil at an average rate of 1,270 BPD. Some 42 such retorts in 14 clusters must be burning simultaneously when the anticipated full Phase II

4.0 MINE DEVELOPMENT PLAN

4.1 Introduction

.1 Three-Phase Mining Plan (Continued)

production of some 53,~~300~~ 340 BPD is achieved at the close of Phase I. The last will have burned out by mid-1993.

Phase III. The Phase III retorts are somewhat larger in cross sectional area than those of Phase II, being 168 feet wide and 400, 405 or 422 feet long. Such differences in size result from an effort to maximize overall resource recovery by fitting as many of the larger retorts as possible within the remaining tract area. Restraints to this effort include the irregular tract boundaries, the mandated boundary pillars, and the necessary design considerations. The Phase III retorts also will be rubblized from two void levels but, unlike those of Phases I and II, will have a dynamic, or soft pillar, design that calls for only 50-ft pillars between adjoining retort clusters. Such pillars are incapable of supporting the overburden load and thus will fail and transfer the load onto the retort rubble columns.

The Phase III retorts will occupy the eastern and western portions of the tract on either side of the central section containing the static-design retorts of Phases I and II and the surface support, process, and retort facilities. The retorts within these two areas are arranged in 11 mining panels of various sizes comprising 14 to 17 clusters of 5 to 11 retorts each. Over its life, the average Phase III retort is expected

4.0 MINE DEVELOPMENT PLAN

4.1 Introduction

.1 Three-Phase Mining Plan (Continued)

to yield a total of about 403,000 barrels of shale oil at an average rate of 1,375 BPD. Some 40 such retorts must be burned simultaneously to achieve the same level of production as in the earlier phases.

The 1,378 Phase III retorts are capable of maintaining this production over a period of nearly 35 years, or until the year 2028 when this first mining horizon of the tract will be depleted.

.2 Resource Recovery

The 290-ft stratigraphic horizon selected for MIS retorting contains an equivalent in-place resource of 2.8 billion barrels of shale oil over the full 5,094 acres of the tract. However, mining is restricted over some 505 acres of the tract comprising the various shaft and boundary pillars. The remaining 4,589 acres available for mining contain an equivalent in-place resource of 2.52 billion barrels of shale oil. The three-phase mining project now planned will result in an overall recovery of 1.05 billion barrels of shale oil, or some 41.8 percent of the available resource. MIS operations will account for 63.4 percent, or 668 million barrels, of such recovery; and the remaining 36.6 percent, or 386 million barrels, will be derived from surface retorting of the raw shale produced from MIS void excavation and other mine development within the selected retorting horizon. An

4.0 MINE DEVELOPMENT PLAN

4.1 Introduction

.2 Resource Recovery (Continued)

additional 27 million barrels of shale oil will be recovered from surface retorting of the raw shale excavated on two mine levels that fall above and below this horizon, or outside the resource base. Table 4.1 gives a breakdown of the shale that will be retorted and the oil that will be recovered during each phase of operation.

.3 Adverse Effects

Oil shale strata within the tract boundaries has an aggregate thickness of approximately 1,850 feet, an average grade of about 19 GPT, and an equivalent in place oil shale content of some 13 billion barrels. The 1,100 feet of alternating richer and leaner oil shale zones that underlie the MIS retort horizon has about the same average grade and an equivalent oil content of some 7.8 bilion barrels. Only one such zone contains oil shale of sufficient grade and thickness for possible conventional mining under present conditions. This is the R-4 Zone which contains some 55 feet of 30-GPT shale begining about 430 feet below the retort horizon. Other thicker but leaner zones may be amenable to MIS recovery. Both conventional and MIS recovery methods for these deeper resources will be evaluated before the initial retort horizon has been depleted. Any evaluation on the basis of present technology and economics would not be meaningful. The revised mining plan should have no

TABLE 4.1 Oil Shale Retorted and Shale Oil Recovered Over Life of Three-Phase Project

Source of Oil Shale and Phase of Operation	Total Retorting		MIS Retorting[1]		Surface Retorting[2]	
	Oil Shale Retorted, Tons x 10^6	Shale Oil Recovered, Bbls x 10^6	Oil Shale Retorted, Tons x 10^6	Shale Oil Recovered, Bbls x 10^6	Oil Shale Retorted, Tons x 10^6	Shale Oil Recovered, Bbls x 10^6
225 Phase I Retorts	116.79	54.56	89.67	38.16	27.12	16.40
Phase I Mine Development	12.73	8.21			12.73	8.21
Subtotal Phase I	129.52	62.77	89.67	38.16	39.85	24.61
202 Phase II Retorts	242.61	115.79	188.27	75.17	54.34	40.62
Phase II Mine Development	8.93	5.87			8.93	5.87
Subtotal Phase II	251.54	121.66	188.27	75.17	63.27	46.49
1,378 Phase III Retorts	1,791.05	854.87	1,389.90	554.96	401.15	299.91
Phase III Mine Development	22.27	15.11			22.27	15.11
Subtotal Phase III	1,813.32	869.98	1,389.90	554.96	423.42	315.02
Total From Retort Horizon	2,194.38	1,054.41	1,667.84	668.29	526.54	386.12
Available Resource Within Retort Horizon[3]	3,921.70	2,521.10	3,921.70	2,521.10	3,921.70	2,521.10
Percent Recovery	55.9	41.8	42.5	26.5	13.4	15.3
Mine Development Outside Retort Horizon	66.52	27.43			66.52	27.43
Total For New Mine Plan	2,260.90	1,081.84	1,667.84	668.29	593.06	413.55

1 Theoretical recovery from MIS retorts is 65% of Fischer Assay of oil shale retorted.
2 Recovery from surface retorting assumed to be 100% of Fischer Assay.
3 Elimination of shaft and boundary pillars leaves only 4,589 acres of Tract available for mining.

4.0 MINE DEVELOPMENT PLAN

4.1 Introduction

.3 Adverse Effects (Continued)

adverse effect on the deeper resources. To the contrary, the various shafts and other facilities thus provided could actually facilitate their development and extraction.

Approximately 460 feet of leaner oil shale, averaging about 14 GPT and containing some 2.4 billion barrels of shale oil equivalent, overlies the retort horizon. Conventional mining of such deposits is unlikely, and even MIS methods may not be economically feasible. Possible methods for the recovery of this resource also will be evaluated later. No adverse effect on any possible future mining of the upper deposits would be expected from the proposed static design of the Phase I and II retorts in the central part of the tract. However, the proposed dynamic design of the Phase III retorts on the eastern and western sides could result in some limited subsidence of the overlying deposits which may preclude any future mining of them in the areas so affected.

4.2 Mining Plan and Schedule

.1 Mining Plan

Under the three-phase mining plan, the selected oil shale horizon will be developed in panels of retort clusters that are so arranged with respect to tract boundaries and the existing and planned shafts as to provide an orderly sequence of mining

4.2 Mining Plan and Schedule

.1 Mining Plan (Continued)

and retorting over the full tract. The overall mine layout as now planned is shown on drawings EM-101 through EM-106.

Shafts. The six mine levels necessary for the planned MIS retorting system will be developed either directly or indirectly from three vertical shafts now under construction. Certain of these levels ultimately will be connected to one or more of the four additional shafts called for in this plan. Now under construction are the Production, Service, and V/E shafts; and yet to be started are a mine air intake shaft, a pair of mine air exhaust shafts, and an off-gas shaft for the MIS process. Details of these seven shafts and their facilities are provided in Section 4.3. The particular mine levels that connect with each shaft are indicated on drawing EM-116.

Shaft Level Stations. Level stations of various sizes and complexities will be provided at both the V/E shaft and in the Production/Service shaft area. Stations at the V/E shaft will contain facilities for initial level development and the permanent mine dewatering system, while those in the Production/Service shaft area will have all the other permanent facilities for mine development and raw shale handling. Details of these shaft level stations and their facilities are given in Section 4.4.1.

4.0 MINE DEVELOPMENT PLAN

4.2 Mining Plan and Schedule

.1 Mining Plan (Continued)

Mine Levels. The mine levels required for retort development and operation will include, in decending order, the Ignition level, the Upper Void level, the Ventilation level, the Intermediate Void level, the Lower Void level, and the Gas level. Drawings EM-108, 110, and Figure 4.1 indicate the vertical spacing of these six levels with respect to each other and to the 290-ft retort horizon.

As their names imply, the Upper, Intermediate, and Lower Void levels will be located at the top, middle, and bottom of the retort horizon where they will provide the means of excavating the void volume for retort rubblization as well as for the rubblization itself. The Intermediate Void level will not be required for rubblization of the Phase II and Phase III retorts and hence will not extend beyond the Phase I retort area.

The Ventilation level will be driven midway between the Upper and Intermediate Void levels where it will make connection with the intake and exhaust shafts and function as a distribution or collection network for intake or return air to or from working areas on the other levels.

The Ignition level will be developed 138 feet above the retort horizon as a means of igniting the retort rubble and controlling the retorting process through holes drilled into the top of each

4.0 MINE DEVELOPMENT PLAN

4.2 Mining Plan and Schedule

.1 Mining Plan (Continued)

retort. During retorting, this level will serve as a path for retort combustion air and provide access for combustion control steam lines and various monitoring and control circuits.

The lowermost Gas level will be driven 87 feet below the retort horizon as a collection system for the retort off-gases to be exhausted up the Gas shaft, as well as for the retort liquids to be pumped to the surface through boreholes after preliminary treatment on the Lower Void level. Except for its connection with the Gas shaft, this level will be entirely isolated from other mine workings.

Level Development. Mine level development is covered in Section 4.4.2. and only a summary of its basic features is given below.

The Ignition and the three Void levels will be developed from the Production/Service shaft stations; the Ventilation level, through ramps from the Upper Void level; and the Gas level, through ramps from the Lower Void level. Some intitial development on the Ignition and Void levels will be carried out from the V/E shaft station, and the first sections of the Gas level will be driven from the Gas shaft.

Primary development on all levels will consist of double panel drifts interconnected by crosscuts at nominal 315-ft intervals.

4.0 MINE DEVELOPMENT PLAN

4.2 Mining Plan and Schedule

.1 Mining Plan (Continued)

Mining panels will be delineated by multilevel networks of these primary development drifts superimposed within the continuous 300-ft-wide barrier pillars around such panels. The superimposed networks of double panel drifts are identical on all but the Gas level where only alternate pairs of the north-south drifts will be needed and only a single central pair of east-west drifts connecting with the Gas shaft will be provided.

Secondary development from the networks of primary panel drifts will involve cluster access drifts for retort void excavation and rubblization on the three void levels; ignition drifts with interconnecting crosscuts over the retort clusters on the Ignition level; and oil and gas collection drifts below the retort clusters on the Gas level. Common fuel, air, and steam injection holes for retort ignition, operation, and control will be drilled to the top of each retort from the ignition drifts; and product recovery raises will be bored to the bottom of each retort from the collection drifts. The Ventilation level will contain no secondary development other than the series of ventilation and raw shale transfer raises that will be bored from the Lower Void level to the Ignition level within the barrier pillars along each north-south pair of panel drifts, midway between the adjacent clusters in each mining panel. Secondary development of the retort clusters within the mining

4.2 Mining Plan and Schedule

.1 Mining Plan (Continued)

panels is covered in Section 4.5. Drawings EM-107 through EM-110 indicate the extent of such development.

MIS Retorts. The three-phase mining plan will permit full scale shale oil production to be achieved as early as possible using the best available MIS technology with later optimization of such technology for increased resource recovery as experience is gained.

The 225 Phase I retorts used to initiate full production are confined to four adjoining panels in the center of the Tract. Six of these smaller square retorts will be aligned in east-west rows or clusters, and each panel will comprise 8 to 10 of such six-retort clusters surrounded on all sides by a 300-ft barrier pillar containing the superimposed pair of panel drifts on each mine level.

The 202 larger rectangular retorts of Phase II will be confined to eight mining panels laid out between the central retort area of Phase I and the north or south boundaries of the tract. These panels will be the same size as those for Phase I and will contain up to 10 three-retort clusters. Their mining sequence also will be similar to that of Phase I with some differences in development detail.

4.2 Mining Plan and Schedule

.1 Mining Plan (Continued)

The still larger rectangular retorts of Phase III will occupy the eastern and western portions of the Tract on either side of the central portion containing the Phase I and II retorts and the main surface plant and facilities. The 1,378 Phase III retorts will be arranged in 11 mining panels of various sizes comprising 14 to 17 clusters of 5 to 11 retorts each. Retorts on the western side of the Tract will be fully developed and burned before any development on the eastern side is attempted.

Drawings EM-101 through 106 indicate the general layout of the retorts, retort clusters, and mining panels for each phase of the mining plan. Details of retort and cluster development for each phase are shown in Drawings EM-107 through 110.

The locations chosen for the initial retorts not only will provide for the largest group of panels unobstructed by property boundaries, but also will allow for possible changes in the mining plan for the next set of panels. Such flexibility is important to the phased development concept.

The east-west orientation of the retort clusters will permit mining to progress in both a north and south direction from the center and will provide the most systematic layout for the smoothest flow of the mined raw shale to the Production shaft. Such orientation also will align the clusters and panels

4.0 MINE DEVELOPMENT PLAN

4.2 Mining Plan and Schedule

.1 Mining Plan (Continued)

with the property boundaries so as to minimize loss of retorts at the boundaries due to staggering.

Panel Mining. In order to maximize operating efficiency and reach full production in the shortest period, a consistant plan for panel mining will be followed during the early years of mine life. Under this plan, two adjacent panels will be mined concurrently so as to reduce the number of retorts under development at any one time. Mining within the first double row of panels will proceed both north and south from the center of the tract until the tract boundaries are reached. At this time, mining of the next double row of panels will start at the center of the tract and proceed north alongside the already burned out and cooling retort clusters in the initial panels. To prevent mine personnel from working next to a burning retort, each cluster of retorts will be ignited only after the next succeeding cluster in the mining sequence has been fully developed, rubblized, instrumented, and permanently sealed off. Mining of the Phase III panels in the later years of mine life will follow the same general plan although considerable changes in operating procedures will be required because of their different sizes and non-symmetrical layouts.

Details of the phased development and operations of the MIS retorts are covered in Section 4.5.

4.0 MINE DEVELOPMENT PLAN

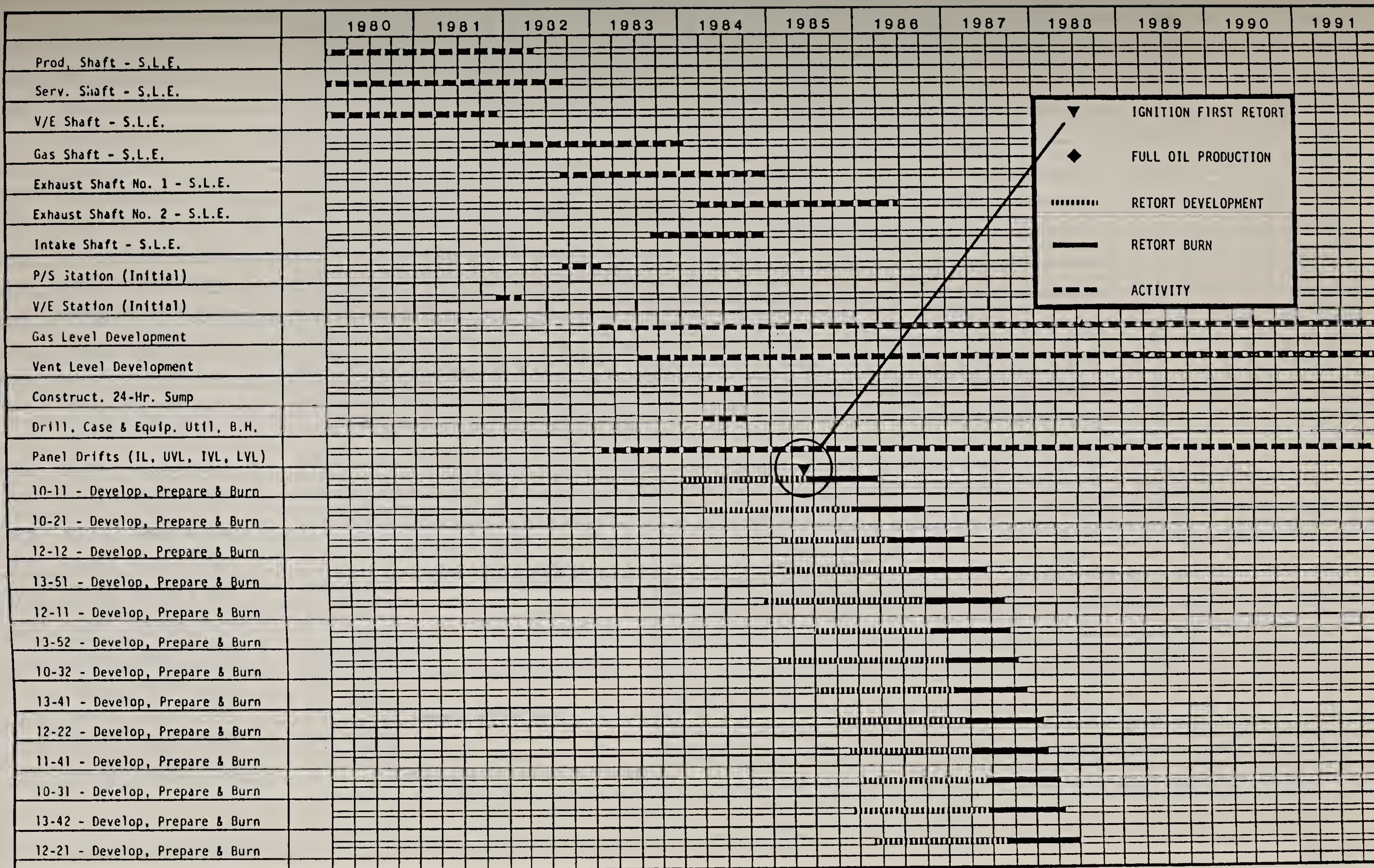
4.2 Mining Plan and Schedule

.2 Schedule

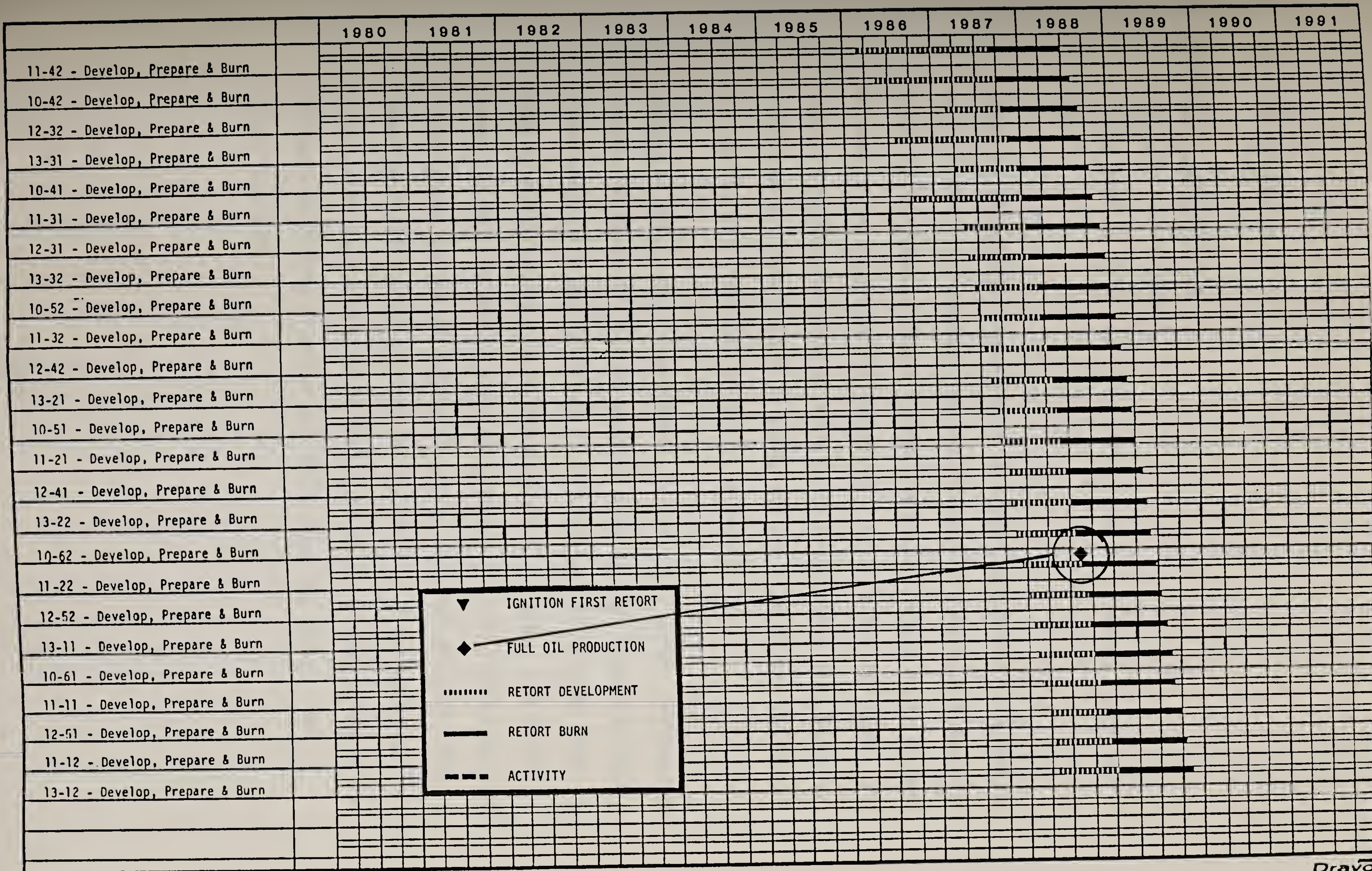
Shaft Sinking and Initial Level Development. Mine level development is keyed to the completion of the Production, Service, and V/E shafts which are now under construction but are not scheduled to be equipped and fully operational until late in 1982. Initial level development from the V/E shaft toward the Production/Service shafts and from the latter shafts toward the Phase I retort area in the center of the tract will start early in 1983, after the needed shaft stations have been cut. Such development will continue concurrently with the construction of the four additional shafts called for in this plan. These include a retort off gas shaft, a pair of mine air exhaust shafts, and a mine air intake shaft. The Gas shaft, which is essential to MIS operations, will be started as soon as the V/E shaft is operational in December 1981, and will be completed in January 1984. The last of the other shafts will be finished in mid-1986.

Phase I Retorting. Development of the smaller square retorts of Phase I will begin at the end of 1983, but the first of these retorts will not be ignited until May 1985. Full MIS shale oil production will be achieved in August 1988 when 96 retorts in 16 clusters are burning simultaneously. The last of the 225 Phase I retorts will have burned out late in 1989.

A schedule of major mining activities through Phase I of this plan is provided in Figure 4.2. The panel and cluster numbering



1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
Prod. Shaft - S.L.E.
Serv. Shaft - S.L.E.
V/E Shaft - S.L.E.
Gas Shaft - S.L.E.
Exhaust Shaft No. 1 - S.L.E.
Exhaust Shaft No. 2 - S.L.E.
Intake Shaft - S.L.E.
P/S Station (Initial)
V/E Station (Initial)
Gas Level Development
Vent Level Development
Construct. 24-Hr. Sump
Drill, Case & Equip. Util. B.H.
Panel Drifts (IL, UVL, IVL, LVL)
10-11 - Develop, Prepare & Burn
10-21 - Develop, Prepare & Burn
12-12 - Develop, Prepare & Burn
13-51 - Develop, Prepare & Burn
12-11 - Develop, Prepare & Burn
13-52 - Develop, Prepare & Burn
10-32 - Develop, Prepare & Burn
13-41 - Develop, Prepare & Burn
12-22 - Develop, Prepare & Burn
11-41 - Develop, Prepare & Burn
10-31 - Develop, Prepare & Burn
13-42 - Develop, Prepare & Burn
12-21 - Develop, Prepare & Burn
IGNITION FIRST RETORT
FULL OIL PRODUCTION
RETORT DEVELOPMENT
RETORT BURN
ACTIVITY


1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
11-42 - Develop, Prepare & Burn
10-42 - Develop, Prepare & Burn
12-32 - Develop, Prepare & Burn
13-31 - Develop, Prepare & Burn
10-41 - Develop, Prepare & Burn
11-31 - Develop, Prepare & Burn
12-31 - Develop, Prepare & Burn
13-32 - Develop, Prepare & Burn
10-52 - Develop, Prepare & Burn
11-32 - Develop, Prepare & Burn
12-42 - Develop, Prepare & Burn
13-21 - Develop, Prepare & Burn
10-51 - Develop, Prepare & Burn
11-21 - Develop, Prepare & Burn
12-41 - Develop, Prepare & Burn
13-22 - Develop, Prepare & Burn
10-62 - Develop, Prepare & Burn
11-22 - Develop, Prepare & Burn
12-52 - Develop, Prepare & Burn
13-11 - Develop, Prepare & Burn
10-61 - Develop, Prepare & Burn
11-11 - Develop, Prepare & Burn
12-51 - Develop, Prepare & Burn
11-12 - Develop, Prepare & Burn
13-12 - Develop, Prepare & Burn
IGNITION FIRST RETORT
FULL OIL PRODUCTION
RETORT DEVELOPMENT
RETORT BURN
ACTIVITY

Dravo

4.0 MINE DEVELOPMENT PLAN

4.2 Mining Plan and Schedule

.2 Schedule (Continued)

system used in this figure is referenced on drawings EM-101 and 102.

Phase II Retorting. In order to maintain full production, development of the large rectangular retorts of Phase II to the north and south of the central Phase I retort area must start early in 1988, or nearly two years before the Phase I retorts are depleted. Full Phase II production from 42 retorts in 14 clusters will begin at the close of Phase I late in 1989, and the last of the 202 Phase II retorts will have burned out by mid-1993.

Phase III Retorting. Development of the still larger rectangular retorts of Phase III on the western side of the tract also must start before the end of Phase II so that full production from some 40 such retorts can be achieved by that time. The 1,378 Phase III retorts are capable of maintaining full production over a continuous period of nearly 35 years, or until the year 2028, when the first mining horizon of the tract will be depleted. Underground operations would terminate at this time unless pillar recovery or mining of other oil shale horizons should then prove feasible.

4.0 MINE DEVELOPMENT PLAN

4.3 Shafts and Facilities

.1 General

Seven concrete-lined vertical shafts of circular cross section, ranging from 1,105 to 1,842 feet in depth, will be provided for the MIS system of mining and retorting now planned for the lease Tract. Actual or planned locations of these shafts with respect to the Tract boundaries and the multi-level mine development are shown on drawings EM-101 through 106. Drawing EM-116 is a vertical section through all seven shafts indicating their relative elevations and depths and the particular mine levels that make connection with each.

The mine will be developed from the 29-ft-diameter Production and 34-ft-diameter Service shafts which, along with the 15-ft-diameter V/E shaft, are currently being sunk on the tract. Yet to be collared are the Gas shaft for the MIS process, a pair of mine air exhaust shafts, and a mine air intake shaft. The latter exhaust and intake shafts were incorporated in the new plan to meet the increased ventilation requirements for gassy mine operations.

.2 Shaft Locations

The Production and Service shafts lie 300 feet apart in the northwestern quadrant of the Tract, while the V/E shaft is at the northernmost edge of the Tract, some 3,500 to 3,800 feet north of the other two. The Gas shaft and the two Exhaust

4.0 MINE DEVELOPMENT PLAN

4.3 Shafts and Facilities

.2 Shaft Locations (Continued)

shafts will be sunk along the approximate east-west centerline of the tract, respectively in the middle and at the outer limits of the Phase I retort area. The Intake shaft will be formed by the eventual enlargement of a small-diameter exhaust raise that is to be bored in the V/E shaft pillar for use during the initial level development from that shaft. It will be some 225 feet south of the V/E shaft.

.3 Shaft Pillars

Commercial retorting will be restricted, at least initially, within a 1,250-ft radius of both the Production and Service shafts which will create a combined non-retorting pillar area around the two shafts of some 135 acres. However, the size of this large shaft pillar is subject to reduction on the basis of actual retorting experience. For this reason, the underground shaft stations and most of the critical surface support facilities will be confined within a 500-ft radius of each shaft, or within a combined pillar area of about 25 acres. Shaft pillars of 500-ft radius will be provided around each of the other shafts. Underground excavation will not exceed 30 percent of the shaft pillar area.

.4 Shaft Sinking Methods

The Production and Service shafts are being sunk and lined concurrently be methods more or less typical for large circular

.4 Shaft Sinking Methods (Continued)

shafts. Although not aplicable to the Intake shaft, similar methods are expected to be used in one or more of the other planned shafts. The V/E shaft is being sunk, lined, and equipped by standard methods applicable to its smaller size.

Production and Service Shafts. In the two larger shafts, the bottom heading is advanced in alternate benches by conventional drill-blast-muck techniques. Blast holes for the benching rounds are drilled with hand-held pneumatic sinker-type rock drills, and the blasted rock is loaded into sinking buckets by a diesel-powered crawler-mounted front-end loader operating on the shaft bottom. Four sinking buckets are used in the mucking cycle, each pair being raised and lowered in balance by a separate double-drum hoist on the surface. Crossheads on wire rope guides control each bucket during travel in the open shaft.

Both sinking and lining operations are conducted from a multi-deck working platform suspended above the shaft bottom Openings in this platform provide for passage of the sinking buckets to the shaft bottom. The shaft is lined with concrete to a minimum thickness of 1 foot closely behind its excavation. Each succeeding 15-ft section of concrete lining is placed behind a collapsible-type cylinderical slip form. This form

4.3 Shafts and Facilities

.4 Shaft Sinking Methods (Continued)

merely is collapsed inward, lowered 15 feet, and re-expanded for placement of the next section of lining. It is left in place around the last section of lining for protection from blasting during the succeeding excavation cycle.

Sinking operations are ventilated by means of 36-inch ventilation lines extending down the walls of both shafts from high-pressure blowers on the surface. Some 30,000 CFM of intake air is delivered to the bottom of both shafts for use in either normal sinking operations or initial station development off opposite sides of the shafts. In the latter case, the air is diverted to each station heading through separate vent lines. In order to maintain separate ventilation systems, air doors are installed in all station headings interconnecting the two shafts. MSHA standards for gassy mines call for continuous ventilation of all dead-end mine openings. In the case of the longer station headings, this is accomplished using auxiliary blowers in secondary vent lines extending from the main air intake line in each shaft. Shorter facility cutouts in the shaft walls are ventilated by venturi blowers connected to the compressed air lines in each shaft.

Water collection rings are formed in the concrete lining at intervals down the shafts. Water from behind the lining drains

.4 Shaft Sinking Methods (Continued)

to these rings and initially was pumped progressively from ring to ring to the surface. Water from the shaft bottom was pumped to the lowermost collection ring for removal in the same manner. The two shafts were interconnected at about mid-depth to provide for a temporary sump and pump station. Since then, the inflow to both shafts either drains or is pumped via the water rings to this mid-level station, from where it is pumped directly to the surface through either shaft.

Shaft sinking is stopped at the depth of each mine level until the initial sections of the shaft level station are excavated. Such excavation includes a connection between the two shafts as well as a temporary sump and pump station for later level development. The shorter non-connecting excavations on the opposite side of each shaft are extended around the first turning point or otherwise far enough to prevent damage to the shaft when level development is resumed. Due to the heights involved and the equipment available, these initial sections of the shaft level stations stations generally are excavated in two benches--the upper bench being extended its full distance before the lower one is started.

V/E Shaft. The smaller V/E shaft is advanced across its full cross section by drill-blast-muck techniques. Blast holes for the full face rounds are drilled by hand-held sinker drills. A Cryderman

4.3 Shafts and Facilities

.4 Shaft Sinking Methods (Continued)

Shaft Mucker, operated from a work platform suspended above the shaft bottom, loads the blasted rock into a sinking bucket on the shaft bottom. This shaft mucker comprises a clamshell bucket on a moveable telescopic boom suspended from the bottom of a control cage. Air cylinders control operation of the bucket and movement of the boom. The shaft mucker control cage fits within one of the two skip compartments provided in the permanent steel shaft sets, and the complete unit can be raised or lowered in the shaft on one of the hoisting ropes from a double-drum hoist at the surface. At the start of a mucking cycle, the unit is lowered to the bottom of a multi-deck working platform suspended above the shaft bottom. The single sinking bucket used in the operation is hoisted, unbalanced, in the other skip compartment of the shaft sets. A crosshead riding on wooden guides in this compartment controls bucket travel through the shaft and into the surface headframe tower for automatic dumping into a truck-load-out bin.

The V/E shaft is lined with concrete in much the same manner as the two larger shafts. However, in this case, the permanent steel dividers and buntons forming the manway, service, and hoisting compartments within the shaft are installed closely behind the concrete lining. Water is handled the same way, and a temporary sump and pump station also was provided about mid-depth in the shaft.

4.3 Shafts and Facilities

.4 Shaft Sinking Methods (Continued)

The V/E shaft encounters appreciably more ground water during sinking than do the two larger shafts. In order to reduce water inflow, a continuous grout curtain is carried some 125 feet in advance of the shaft excavation.

Sinking operations are stopped while the necessary holes are drilled and pressure grouted from the shaft bottom. Similar grout curtains also were planned for the two larger shafts but have yet to be implemented due to the smaller and more readily handled inflows encountered to date.

As in the two larger shafts, sinking in the V/E shaft is stopped at the depth of each of its intersecting mine levels until the initial sections of the shaft level stations are excavated. Such excavations extend short distances from both sides of the shaft and also include a temporary sump and pump station for later level development.

.5 Production Shaft and Facilities

The Production shaft will provide the means of hoisting raw shale from mine and retort development to the surface for stockpiling and/or retorting. Under the earlier mining plan, this shaft also would have served as the main exhaust for mine ventilation, and a concrete-lined by-pass of the shaft collar was provided for this purpose. It now will provide such service only on an interim basis

4.0 MINE DEVELOPMENT PLAN

4.3 Shafts and Facilities

.5 Production Shaft and Facilities (Continued)

until the first Exhaust shaft is completed. At that time, the fans will be transferred to the Exhaust shaft; and the Production shaft will thereafter function as an air intake for the mine.

The Production shaft is 29 feet in diameter inside its concrete lining and ultimately will be sunk to a depth of 1,842 feet below the surface, or 225 feet below the Lower Void level of the mine. Its extension below this level will provide room for the raw shale surge bins, skip loading pockets, skip tail ropes, and guide rope terminals. An inclined ramp from the lower level to the shaft bottom will facilitate clean up of shale spillage during skip loading.

The permanent 313-ft-high reinforced concrete headframe tower was erected over the shaft collar as soon as the initial collar section of the shaft had been excavated and was temporarily equipped for sinking the remainder of the shaft. Double-drum hoists in separate ground-level enclosures were provided for the sinking operations. These will be removed after the permanent production hoists are installed in the headframe tower. The headframe tower was constructed with two integral 800-ton-capacity ore bins which are not used in shaft sinking but will be used during production operations. Rock from shaft excavation passes through these bins and accumulates on the ground outside the headframe tower, from where it is picked up and loaded

4.0 MINE DEVELOPMENT

4.3 Shafts and Facilities

.5 Production Shaft and Facilities (Continued)

into trucks for surface disposal. Permanent apron feeders and belt conveyors will be provided for this purpose during mining operations. The shaft will be equipped with its other permanent facilities after sinking is completed. These include the compartment dividers and skip guides; the surge bins and loading pockets below the Lower Void level; and the hoisting units, collar doors, material handling equipment, dust collection system, and temporary exhaust fans in the headframe tower. Facilities for changing the ropes on the friction hoists at the Production and Service shafts will also be provided on the sump and pump station that interconnected both shafts at about mid-depth. The general arrangement of the Production shaft and its permanent facilities is shown on Figure 4.3. Figure 4.4 shows the concrete headframe towers of the Production and Service shafts during sinking operations.

Raw shale will be hoisted in the Production shaft by two 9,500-HP friction hoists mounted in the headframe tower. Electric power for the direct-connected D.C. hoist motors will be provided through a thyristor circuit having 13.8-Kva A.C. input. Two 52.5-ton-capacity bottom-dump skips, each weighing 68 tons, will be operated in counter balance from each hoist. These will be suspended from opposite ends of six 2-1/8-inch hoisting ropes passing around the 170-inch-diameter friction wheel of the

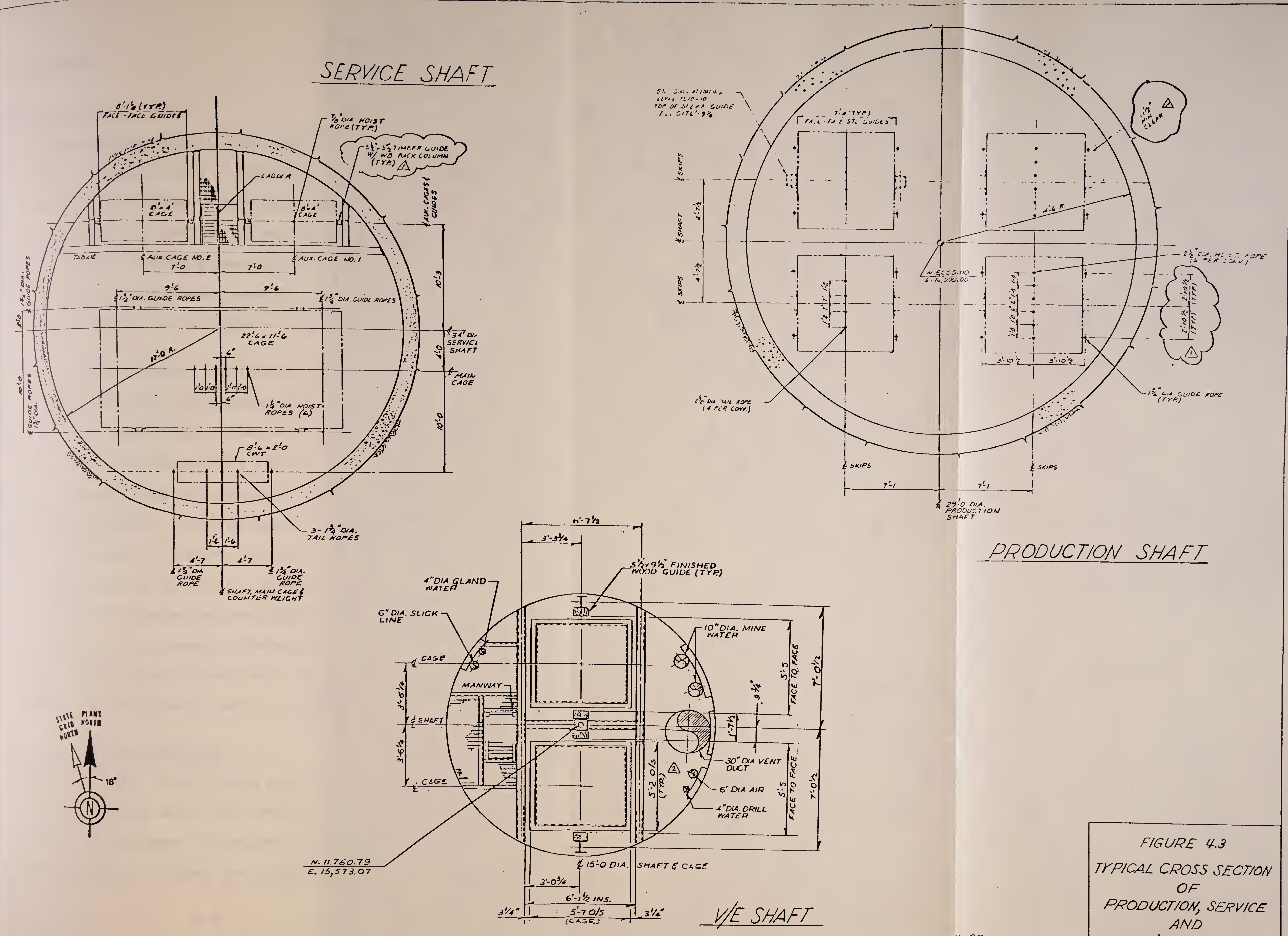


FIGURE 4.3

TYPICAL CROSS SECTION OF PRODUCTION, SERVICE AND V/E SHAFTS

4.3 Shafts and Facilities

.5 Production Shaft and Facilities (Continued)

hoist. The opposite ends of four 2-5/8-inch tail ropes will be connected to the bottom of each skip. Each skip will be raised and lowered in the shaft on its own set of four wire rope guides. These flexible guides will be supplemented by rigid steel guides at the loading pocket in the shaft bottom and the dumping point in the headframe tower.

A skip will be filled at the loading pocket in the shaft bottom, hoisted 1,921 feet to the dumping point in the headframe tower, dumped, and lowered again to the shaft bottom in an overall cycle time of 188 seconds (3.1 minutes). The maximum hoisting speed reached during this cycle will be 2,920 feet per minute (33 miles per hour). Hoisting capacity of the two-hoist/four-skip system over its nominal 18.5 hours of daily operation will be 74,400 tons per day (TPD). Its design capacity will be 80 percent of this amount, or some 60,000 TPD. The system will be operated in either a manual, semiautomatic, or fully automatic mode. During automatic operations, interlocking controls will prevent the simultaneous starting or passing of all four skips.

.6 Service Shaft and Facilities

The Service shaft, which is being sunk concurrently with the adjacent Production shaft, will provide for the passage of men, material, and equipment into and out of the mine. It also will serve as a mine air intake, and a concrete-lined by-pass of the

4.3 Shafts and Facilities

.6 Service Shaft and Faciliites (Continued)

shaft collar was provided for such purpose. This shaft is 34 feet in inside diameter and ultimately will be sunk to a depth of 1,753 feet below the surface, or 134 feet below the Lower Void level. Its extension below this level will provide room for cage unloading, cage and counterweight tail ropes, and rope guide terminals.

As in the case of the Production shaft, the permanent 178-ft-high reinforced concrete headframe tower for the Service shaft (Figure 4.3) was erected early for use in sinking all but the collar section of the shaft. Temporary ground-level sinking hoists were also provided for use with this tower. The shaft will be equipped with its other permanent facilities after sinking is completed. These include the hoisting units in the headframe tower as well as the compartment dividers, manway or ladderway, cage guides, and certain utility lines in the shaft. A ground-level collar house with a bridge crane will facilitate handling of mine material and equipment at the shaft collar. Mine personnel will board the man cage on a sublevel of the headframe tower that will be accessible through an underground passageway from the changehouse. The general arrangement of the Service shaft and its permanent facilities is shown in figure 4.3.

.6 Service Shaft and Facilities (Continued)

A 1,500-HP friction hoist for operating a large double-deck man and materials cage in balance with a counterweight and two 300-HP single-drum hoists, each for the unbalanced operation of a small auxiliary man cage, will be mounted in the headframe tower. The direct-connected D.C. motor on the friction hoist and the reduction-gear-coupled D.C. motors on the smaller hoists are powered through thyristor circuits having A.C. inputs of 4.16 Kva and 480v, respectively. The friction hoist will operate with six 1-1/2 inch head ropes on its 120-inch friction wheel and three 1-3/4 inch tail ropes on its cage and counterweight. Each auxiliary cage will be operated on a 7/8-inch rope suspended directly from the drum of its hoist.

The large man and material cage will travel on four wire rope guides supplemented by rigid steel guides at the shaft collar and each level station. Cam-type safety dogs on this cage will grip the guide ropes and slow the downward movement of the cage should tension on the hoisting ropes be relaxed. Arrestor timbers above the shaft bottom will dissipate the remaining energy of the descending cage before it reaches the crash bars at the bottom. This 12- by 24-ft 52,000-lb cage will handle up to 300 men on its two decks at maximum speeds of 1,500 feet per minute (17 miles per hour). Gates at both ends of the cage will permit loading and unloading

4.3 Shafts and Facilities

.6 Service Shaft and Facilities (Continued)

from either side of the shaft. Landing chairs will not be provided at the shaft collar or the mine levels inasmuch as the stretch in the headropes will be negligible after the initial break-in period.

The counterweight for the large cage will travel on two wire rope guides in a separate shaft compartment. Its operating weight will depend on cage loading and will be adjustable in increments up to 82,000 pounds. A counterweight of about 64,000 pounds will be required for normal cage operations after the initial break-in period.

The auxiliary man cages will travel on wooden guides in separate shaft compartments and will be equipped with standard safety dogs that engage these guides when tension in the hoisting rope is relaxed. Each of these 4-by 8-ft, 3,000-lb, single-deck cages will handle 16 to 20 men or 5,000 pounds of other pay load at speeds of up to 800 feet per minute (9 miles per hour).

Each of the three hoisting units for the Service shaft will provide for station call and automatic control from the cage, control at creep speed for cage spotting at each level station, and manual control from the operating console in the headframe tower. Overspeed and overtravel controls also will be incorporated in these units, and the main man and materials hoist will

4.3 Shafts and Facilities

.6 Service Shaft and Facilities (Continued)

be equipped with air-released caliper brakes. All conditions of equipment or operations will be monitored, and any condition hazardous to personnel or equipment will initiate a shutdown of the affected unit.

.7 V/E Shaft and Facilities

The V/E (Ventilation and Escape) shaft, now being sunk on the northern boundary of the Tract, will serve as an intake for mine air as well as an alternate escape route for underground personnel in the event of a mine emergency. The permanent mine dewatering system will discharge through this shaft. It also will provide for men and material access and muck removal during initial mine level development.

The V/E shaft is 15 feet in diameter inside its concrete lining and will be bottomed at a depth of 1,697 feet below the surface, or 126 feet below the Lower Void level. Its extension below the lower mine level will provide room for a 600-ton live storage bin, skip loading pockets, sump pumps, and a clean-up ramp from the lower level. The general arrangement of the shaft and its permanent facilities are shown on Figure 4.3.

The shaft is provided with a 145-ft-high A-frame-type structural steel headframe that is fully enclosed for weather protection.

4.3 Shafts and Facilities

.7 V/E Shaft and Facilities (Continued)

This structure contains two 10-ft-diameter sheave wheels for the hoisting ropes, automatic dumping scrolls for the muck skips, and a 275-ton truck-load-out muck storage bin. Figure 4.4 shows the V/E shaft headframe and hoist house.

The permanent 2,000-HP double-drum geared and clutched hoist was provided for unbalanced hoisting during shaft sinking, but will be operated with a pair of cage-over-skip conveyances in balance after sinking is completed. The two 1,000-HP D.C. hoist motors are powered by a pair of 750-KW D.C. generators both driven by a 2,200-HP A.C. synchronous motor. This hoist is equipped with hydraulic-released dead-weight brakes, clock-type depth indicators, and the usual overspeed and overtravel devices for manual operation only. It is mounted at ground level in a corrugated metal and concrete hoist house about 150 feet from the shaft collar.

Electric power for project start-up operations, including shaft sinking, is provided by on-tract diesel generators. These will be phased out as soon as a full-capacity electric transmission line has been extended to the tract but will be retained on standby as emergency backup for the auxiliary and emergency man hoists at the Service and V/E shafts, as well as for the main mine ventilation fans.

PHOTO TO BE SUPPLIED
BY OXY

HEADFRAME TOWERS
FOR PRODUCTION AND SERVICE SHAFTS

PHOTO TO BE SUPPLIED
BY OXY

V/E SHAFT HEADFRAME AND HOIST HOUSE

Fig. 4-4

.0 MINE DEVELOPMENT PLAN

.3 Shafts and Facilities

.7 V/E Shaft and Facilities (Continued)

The cage-over-skip conveyances for man, material, and muck hoisting in the completed shaft will be operated on wooden guides in separate shaft compartments from individual 1-3/4 inch hoisting ropes. Standard safety dogs on these units will engage the wooden guides should tension on the hoisting rope be relaxed. Each unit will comprise a 9-ton-capacity bottom-dump muck skip suspended below a 5-by 5-ft single-deck man and materials cage. The cage will have a capacity of some 12 men and a pay load rating of 11,000 pounds. Maximum hoisting speeds will be 800 feet per minute (9 miles per hour) with men aboard, or about 2,000 feet per minute (23 miles per hour) with only materials or muck. The overall hoisting cycle for each unit will be approximately 162 seconds, which is equivalent to a combined hoisting capacity for both skips of about 400 tons per hour. About 12.5 hours of hoisting at this rate will meet the 5,000 tons per day hoisting capacity called for in the shaft design.

.8 Other Shafts and Facilities

The four other shafts called for in this mining plan, include the Gas shaft for the offgases from the MIS retorts, the No. 1 and No. 2 Ventilation shafts for mine air exhaust, and the Intake shaft for mine air intake. All four will be concrete-lined vertical shafts with circular cross sections of 34 feet in inside diameter. Because of their intended end uses, all will

4.3 Shafts and Facilities

.8 Other Shafts and Facilities (Continued)

be smooth lined without any permanent internal structures; and none will be equipped with permanent hoisting facilities.

Gas Shaft. The Gas shaft will be sunk 1,734 feet from the surface to the Gas level of the mine to exhaust retort offgases collected on that level to the surface for processing. It will be lined with a minimum thickness of 18 inches of heat - and chemical-resistant concrete during the sinking operation. Initial level development will be conducted from this shaft as soon as sinking is completed. In order to preserve the integrity of the shaft lining, two of the three main level collection drifts will be ramped up so that all intersect the shaft at different elevations.

The burning retorts and their offgas collection system will be isolated from other mine workings. A slight vacuum is maintained on both to prevent offgas leakage into these workings. The Gas shaft will be located close to the center of the tract to minimize pressure drop in the offgas collection drifts as well as the amount of level development needed before ignition of the first retorts.

Upon completion of sinking and initial level development, the shaft collar will be enclosed by a metal duct leading to the nearby offgas scrubbing and compression section of the surface

4.0 MINE DEVELOPMENT PLAN

4.3 Shafts and Facilities

.8 Other Shafts and Facilities (Continued)

processing facilities. There, the entrained oil and water vapor and most of the byproduct ammonia will be recovered, leaving a clean low-Btu boiler fuel for the process steam plant. It is the in-line exhaust blowers following this section that will draw the retort offgases from the mine and force the scrubbed gas to the burners of the steam boilers.

Exhaust Shafts. The No. 1 and No. 2 Ventilation shafts will be sunk respectively 1,389 and 1,105 feet from the surface to the ventilation level of the mine to exhaust dust-and fume-laden return ventilation air from the mine. Only the ventilation level will connect with these shafts. The main exhaust fans will be mounted at the collars of both shafts when shaft sinking and initial level development are completed. These reversible fans will be of a permissible type with explosion doors. Emergency stand-by electric power for the operation of the main fans will be provided by the diesel generator units now in temporary use for the project operations.

Intake Shaft. The Intake shaft, which will serve as the principal route for fresh air entering the mine workings, is to be 1,388 feet deep and connected to both the Upper Void and Ventilation levels of the mine. It will be formed by enlarging an 8-ft-diameter bored raise that is to be provided for the temporary

.0 MINE DEVELOPMENT PLAN

.3 Shafts and Facilities

.8 Other Shafts and Facilities (Continued)

exhaust ventilation of the early station and level development from the V/E shaft. This raise will intersect the Upper Void level station some 225 feet south of the V/E shaft.

The methods used for enlarging the bored raise to the finished 34-ft diameter of the Intake shaft will depend largely on the contractor selected for the work. Most likely, the methods used will involve slabbing the walls into the bore and pulling the broken rock from the bore on one of the connecting levels for hoisting to the surface in the adjoining V/E shaft. Concrete lining probably would be placed closely behind the enlarged shaft excavation because of the expected water inflows. A means of heating the mine intake air during the winter will be provided at the collar of the completed shaft.

.4 Development of Stations and Levels

.1 Shaft Level Stations

Permanent shaft stations of various sizes and complexities will be provided on the Ignition level and the three void levels both at the V/E shaft and in the Production/Service shaft area. The adjacent Production and Service shafts will be served by a single common station on each of these levels. Shaft stations will not be required on the Ventilation and Gas levels of the mine inasmuch as both will be developed through ramps from the

other levels and otherwise will not be connected to any of the main access shafts.

V/E Shaft Stations. Level stations at the V/E shaft will contain the facilities for initial level development and the permanent mine dewatering system. The short sections of these stations excavated during shaft sinking incorporated the temporary sumps and pump stations needed for subsequent station and initial level development. In addition to such temporary and permanent water handling facilities, stations on the three void levels will include maintenance and repair shops, equipment parking areas, material and parts warehouses, electrical substations, explosives and fuel storage areas, equipment refueling stations, offices and lunchrooms, sanitary facilities, first aid stations, safety training rooms, fire and ambulance stations, and personnel refuge chambers. The permanent mine dewatering system, which will be installed on the Upper and Lower void levels near the V/E shaft, is covered in Section 4.7. Only an escape route to the shaft will be provided on the Ignition level station.

A 600-ton live storage bin for skip loading will be excavated below the lower level station about 25 feet back from the shaft. This bin will be covered at the station floor by a steel screen,

.4 Development of Stations and Levels

.1 Shaft Level Stations (Continued)

or grizzly, with 12- by 12-inch openings. Development rock from the lower level will be hauled to the shaft station and dumped either directly onto the grizzly or into a feeder-breaker that in turn discharges onto it. Two pedestal-mounted hydraulic rock breakers will be provided to reduce oversize rock not falling through the grizzly. Development rock from the upper levels will be transferred to the lower level through a 6-ft-diameter bored raise that bottoms at one side of the grizzly. A chain curtain with a pneumatic actuator will regulate the flow of rock from the raise onto the grizzly. Smaller grizzlies with a single rock breaker will be provided for dumping into the transfer raise on the upper level stations. A ramp for shaft bottom clean up access also will extend from the lower level station.

An 8-ft-diameter ventilation exhaust raise for initial level development off the V/E shaft will be up-bored from the Ventilation level, through the overlying upper void level station, to the surface. Later this raise will be enlarged to 34 feet in diameter for service as a mine air intake shaft.

Production/Service Shaft Stations. The four level stations provided in the Production/Service shaft area will contain all the permanent facilities for mine development and raw shale handling. The initial sections of these stations, including the

.4 Development of Stations and Levels

.1 Shaft Level Stations (Continued)

temporary sumps and pump stations and the initial connections between the two shafts, were excavated during shaft sinking. The same general facilities provided on the three void level stations off the V/E shaft will also be provided on the Ignition level station and the three void level stations in this area. However, the station excavations and facilities here will be larger and more elaborate. The Lower Void level is the main production level of the mine; and its station in the Production/ Service shaft area, although generally similar in layout, will be about 40 percent larger than those on the upper levels. Figure 4.5 shows the general arrangement of the Lower Void level station planned for the Production/Service shaft area.

The Lower Void level station will include two 5,300-ton raw shale storage bins at the Production shaft, each capable of feeding one pair of muck skips through measuring flasks in the shaft bottom. Raw shale from mine and retort development will be reduced in size with feeder-breakers before being transported to these bins over the belt conveyor system on the lower level. An access ramp for shaft bottom clean up will be provided. The raw shale handling facilities on this lower level station are covered in Section 4.11.

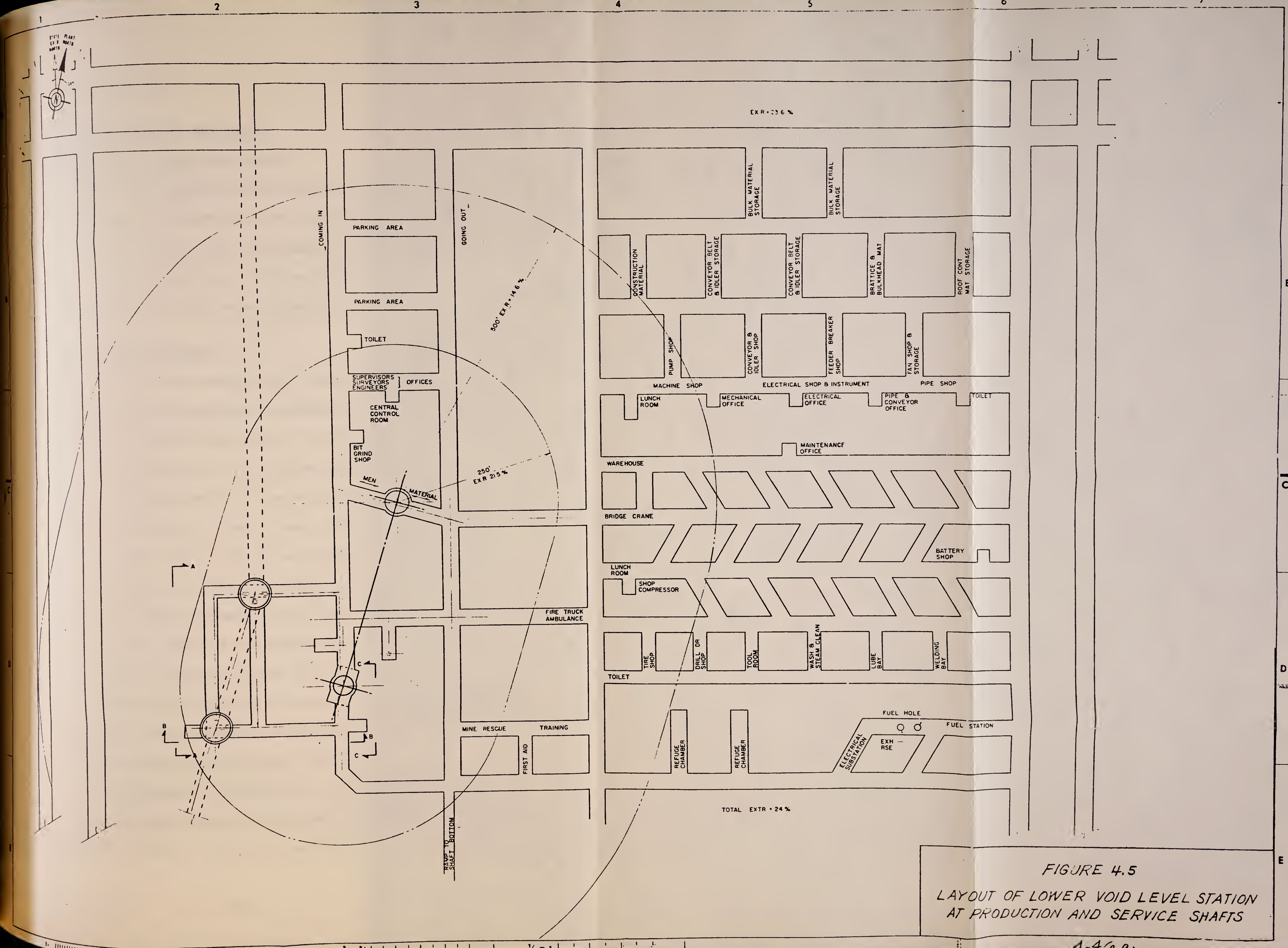


FIGURE 4.5

LAYOUT OF LOWER VOID LEVEL STATION AT PRODUCTION AND SERVICE SHAFTS

4.4 Development of Stations and Levels

.1 Shaft Level Stations (Continued)

The four level stations in this area will be connected by a bored raise for transferring the raw shale from subsequent station and initial level development to the lower level for hoisting to the surface. All four stations will also be interconnected by inclined ramps for mobile equipment passage.

.2 Mine Level Development

The six mine levels necessary for the MIS retorting system and their primary and secondary development either directly or indirectly from the three shafts now under construction were discussed in Section 4.2.1. Primary development of these levels will involve delineation of the mining panels by means of multilevel networks of double panel drifts and crosscuts superimposed within the barrier pillars around each panel. Layouts of the network of primary development drifts on each level during each phase of operations are shown in drawings EM-101 through 106. Secondary development from this primary network will entail a variety of access and service drifts and crosscuts for development of the retort clusters within the mining panels. Details of such secondary development by level and phase are shown on drawings EM-107 through 110 and will be discussed under retort development in Section 4.5. Drawings for Phase III are not included inasmuch as they would be basically the same as those for Phase II. The cross sectional areas of the various

4.4 Development of Stations and Levels

.2 Mine Level Development (Continued)

primary and secondary development headings are indicated on the referenced drawings.

Besides providing access for men and materials to the mining panels for retort development and operation, the primary development drifts on the various levels will serve as mine haulageways and airways. Drifts on the Ignition and the three Void levels will accommodate all permanent pipelines and the electrial system for such development and operation, and those on the Lower Void level also will contain the belt conveyor haulage system and the retort oil/water product handling system.

Plan and Schedule Initial panel drifting will involve driving a connection from the V/E shaft to the Production/Service shaft area on the Lower Void level. Work on other levels will not proceed at this time because of scheduling considerations.

After minimum station work has been completed in the Production/Service shaft area, panel drifting will proceed on the Ignition and the three Void levels to the Phase I retort area so that development of the initial retorts can begin. In order to satisfy ventilation requirements for retort development and operation, panel loops must be completed as quickly as possible.

4.4 Development of Stations and Levels

.2 Mine Level Development (Continued)

Development of the Ventilation level will be carried out concurrently with the other levels through inclined ramps extending from the Upper Void level. On this level, double panel drifts will be driven north and south between the mining panels from a central east-west pair of such drifts connecting with both of the planned Ventilation shafts. The general arrangement of the Ventilation level in the vicinity of the Ventilation and Gas shafts is shown on drawing EM-113.

The Gas level will be developed by a series of double panel collection drifts extending north and south between the mining panels from a central east-west pair of such drifts connecting with the planned Gas shaft. Each north-south pair of drifts will serve two adjacent mining panels. Initial development of this level from the bottom of the Gas shaft will be concrete lined for long term stability. The remainder of its development will be accomplished through access ramps from the Lower Void level. One such ramp would be required for the primary and secondary development of each two adjoining mining panels. A remotely operated system of bulkheads will be installed as level development progresses in order to maintain isolation of the offgases from the burning retorts. All primary and secondary drifts will be lined with refractory shotcrete to provide

4.4 Development of Stations and Levels

.2 Mine Level Development (Continued)

stability and to prevent potential corrosion from the high temperature offgases. The general arrangement of the Gas level in the vicinity of the Gas shaft is shown on drawing EM-114.

Drifting Methods. Panel drifts and other level development headings will be advanced by conventional drill-blast-muck techniques using equipment approved for gassy mines. Large-hole full-face heading rounds will be drilled with drifter-type rock drills mounted on double-boom drilling jumbos. Such rounds will be charged and blasted with ANFO (amonium nitrate-fuel oil mixture), providing a variance to gassy mine regulations for use of this blasting agent can be obtained. A variety of other diesel- and electric-powered mobile face equipment will be used, including blast-hole loaders, roof scalers, rock bolters, vent pipe hangers, utility rigs, auxiliary fans, and trailer-mounted air compressor units. Ground support will be provided by rock bolts supplemented where necessary by wire mesh, roof channels, or shotcrete.

Rock broken in the development headings on the upper levels will be loaded and hauled by diesel-powered trackless equipment to raises for transfer to the Lower Void level. Either end-dump trucks and front-end loaders or self-loading transports (such as LHD's) would be used for this purpose, depending largely on the

4.4 Development of Stations and Levels

.2 Mine Level Development (Continued)

haulage distances involved. On the Lower Void level, rock from the transfer raises, as well as from the development headings on the Lower Void and Gas levels, will be moved to nearby feeder-breakers for size reduction before being transported by belt conveyors to the Production shaft for hoisting to the surface. Details on the mining equipment for level development are included in Section 4.10, and the raw shale materials handling system is covered in Section 4.11.

The simultaneous advance of two nearby drift headings by the same work crew will speed up level development through optimum use of available manpower and equipment. From one to three heading crews will be used for the initial development on each level, and four such crews will be provided during the periods of peak development. After full retort production has been achieved, all development necessary to maintain such production will be accomplished with only a single panel drift crew.

Design Criteria. A typical panel drift round will have a depth of 14 feet, a drill hole spacing of 5 by 5 feet, a drilling penetration rate of 5 feet per minute, and an overall drill-out time of 2.7 hours. An average of 1.2 pounds of ANFO will be used for each ton of rock broken in such rounds. Loading and haulage rates for the brocken rock will range from 155 tons an hour with 35-ton trucks over a haul distance of 800 feet to 57 tons an hour with 50-ton

.0 MINE DEVELOPMENT PLAN

.4 Development of Stations and Levels

.2 Mine Level Development (Continued)

trucks over a haul distance of 6,000 feet. An average of 1 rock bolt will be installed for every two foot of drift advance. The average rate of advance for such drifts will be 36 feet a day, or 1.3 feet per direct man shift.

The mine will be in operation 350 days a year, seven days a week, and three shifts a day although retorting, once started, will continue full time. Mining will be carried out on 20 shifts a week, and one shift a week will be reserved for shaft and equipment maintenance. Actual mining operations will account for 16.5 hours a day, and 18.5 hours a day will be devoted to hoisting raw shale.

.5 Retort Development, Rubblization, Operation, and Production

.1 Retort Development

Clusters of both the smaller square retorts of Phase I and the larger rectangular retorts of Phases II and III extend east to west across the width of their respective mining panels. Development of such clusters from the primary drifts on opposite sides of each panel will generally be the same for all three phases. The only difference will be that void excavation and retort rubblization of the smaller retorts will be accomplished from three levels rather than from two levels as in the case of the larger retorts. The sequence of cluster development is

.0 MINE DEVELOPMENT PLAN

.5 Retort Development, Rubblization, Operation, and Production

.1 Retort Development

governed by rock handling and ventilation considerations, as well as by the constraints against mine personnel working adjacent to a burning retort. Mining from both ends of a cluster will reduce the haul distance in and out of the work areas and is the key to rapid retort development. Drawings EM-107 through 110 show details of the secondary level development for the Phase I and II retorts. Phase III development is not shown but will be basically the same as Phase II.

Upper Void Level. Retort and cluster development on the Upper Void level will be carried out from both ends of the cluster by means of parallel access drifts driven along each side of the cluster from the panel drifts on opposite sides of the mining panel. These two drifts will be excavated to the finished height of the void openings on this level and will be connected by crosscuts at appropriate intervals both for ventilation and to provide the free faces necessary for void excavation. Slabbing from such drifts and crosscuts will create the final void openings within each retort as shown on the drawings. Only minimal ground support will be required over the short life of these openings. All development will be performed by conventional drill-blast-muck techniques using drill jumbos for both drift and slabbing rounds and trackless equipment for haulage of the broken rock to the transfer raises. Other than the slightly

4.5 Retort Development, Rubblization, Operation, and Production

.1 Retort Development (Continued)

greater void height and the different configuration of the void pillars for the larger retorts in Phases II and III, cluster development on this level will be the same in all three phases.

Intermediate Void Level. Retort and cluster development on the Intermediate Void level also will proceed from both ends of the cluster through parallel access drifts extending across the mining panel along each side of the cluster. Inasmuch as the void opening on this level will be 42 feet in height, one such drift will be ramped up and driven at the top of the void horizon while the other will be driven at the bottom. Cross-cuts will be extended across the cluster from both the top and bottom access drifts, at appropriate intervals between the pillar layout shown on the drawings.

A vertical slot parallel to the access drifts will be excavated on one side of each retort to provide the free face necessary to initiate void excavation. Such excavation will be accom-plished by horizontal slabbing followed by vertical benching from the top drift and crosscuts. Broken rock from these operations will be loaded and hauled from the bottom drift and crosscuts as well as from the areas opened by benching. Benching will be accomplished using vertical drilling and blasting methods, and conventional drill-blast-and muck techniques will

.0 MINE DEVELOPMENT PLAN

.5 Retort Development, Rubblization, Operation, and Production

.1 Retort Development (Continued)

be used for the horizontal drifting, crosscutting, and slabbing. Drilling jumbos, ANFO explosives, trackless loading equipment, and trucks (or LHD's) for haulage to the transfer raises will be used in both operations. The short-term void openings created on this level also will require only minimal ground support. The Intermediate Void level will not be required in the development of the Phase II and III retorts.

Lower Void Level. Phase I cluster development on the Upper and Lower Void levels will be identical and will be accomplished in virtually the same manner. Development rock on the upper level will be hauled to raises for transfer to the lower level; but on the lower level it will be hauled to loading points for the belt conveyor on that level.

Elimination of the Intermediate Void level in Phases II and III will be compensated for by increasing the height of the void excavation on the Lower Void level to 60 feet. Such excavation will be accomplished in the same manner, and with the same type of equipment, as that on the Intermediate Void level in Phase I -- slabbing and benching from access openings at the top of the void horizon and mucking from similar openings at the bottom. Broken rock will be hauled to the belt conveyor on the lower level.

.0 MINE DEVELOPMENT PLAN

.5 Retort Development, Rubblization, Operation, and Production

.1 Retort Development (Continued)

Void excavation on the Lower Void level must be completed before the product collection drifts on the underlying Gas level can be started inasmuch as these drift will be ventilated through the series of product drainage raises bored between the two levels.

Ignition Level. Retort and cluster development on the Ignition level will consist of a single ignition drift driven centrally over the top of each cluster from the panel drifts on opposite sides of the mining panels. The Ignition drifts over adjoining clusters will be connected by crosscuts for ventilation and access during retort development and operation. Such crosscuts will fall between each pair of the smaller retorts and in the middle of each of the larger retorts. The ignition drifts and connecting crosscuts will be rock bolted to insure their stability over and beyond the operating life of the retort clusters.

Fuel for iqnition of the oil shale rubble and air and steam for supporting and controlling its continued combustion will flow or be injected through an array of vertical and inclined holes drilled into the top of each retort from the ignition drifts. The inputs of fuel, air, and steam will be distributed evenly over the cross sectional area of the rubble column through 16 such holes in the case of the smaller retorts, and 36 holes in the case of the larger ones. To insure their long-term

.5 Retort Development, Rubblization, Operation, and Production

.1 Retort Development (Continued)

integrity, these 8-inch retort inlet holes will be drilled, and 6-inch steel casing will be grouted in them, after the retorts in each cluster have been rubblized.

Gas Level. Development within the mining panels on the Gas level will consist of a single product collection drift driven centrally below the bottom of each retort cluster from one or the other of the double panel collection drifts located between adjacent panels and serving each. Product collection drifts will be driven on an upgrade of one percent from the central panel drifts to insure drainage of the liquid products from retorting. Such liquids will collect behind a concrete dam placed across the lower end of each collection drift where it joins the panel drift. The retort liquids so collected will in the form of a shale oil/water emulsion which will be pumped through sealed pipe raises to the Upper Void level and thence to holding sumps below that level for time-temperature-gravity separation. The product oil and water fractions separated by this preliminary treatment will be pumped to the surface through boreholes.

The gaseous and liquid products of retorting will flow from the bottom of the retorts to the collection drifts through a series of connecting raises. Seven 8-ft-diameter vertical and

4.0 MINE DEVELOPMENT PLAN

4.5 Retort Development, Rubblization, Operation, and Production

.1 Retort Development (Continued)

inclined raises will be bored from the collection drifts to the bottom of each smaller retort; and 10 inclined raises, from these drifts to the bottom of each larger retort. Such raises also will provide through ventilation during development of the single-entry collection drifts. A grizzly-type retaining screen wil be installed over the top of each raise to prenvent entry of the oil shale rubble from the retorts. The primary and secondary collection drifts will be rockbolted and lined with refractory concrete to provide longterm stability from the potential effects of corrosive and high-temperature retort products.

.2 Retort Rubblization

The oil shale initially mined from each retort, either on the three void levels in Phase I or on the two void level in Phases II and III, represents 23 percent of the retort volume. Blasting the remaining in place oil shale into the full retort volume permits a 30-percent expansion of the broken shale and produces a shale rubble with a void volume, or porosity, of 23 percent. ?

Oil shale has little natural porosity and must be rubbled to introduce the gas flow needed for its in situ retorting and to remove the gaseous and liquid products of such retorting. The porosity thus produced must be uniform across the rubble

.5 Retort Development, Rubblization, Operation, and Production

.2 Retort Rubblization (Continued)

bed to insure an even rate of retorting and to prevent channeling of the retort gases and bypassing of rubblized shale particle. Uniform porosity is dependent on rock fragments of each size range being distributed evenly over the full cross section of the retort. Fragment size and distribution are governed by the blasting techniques used and the void volume available for expansion of the blasted material. The rubble void volume, designed to be on the order of 20 percent, is more than ample for efficient retorting. The blasting procedures have also been demonstrated to provide rubble with average size and distribution for effective retort operation.

The methods and procedures used for oil shale rubblization are the result of extensive research and development by Occidental at its Logan Wash mine, and further refinement and optimization can be expected from the ongoing rock fragmentation program there. Only the general features of retort rubblization will be covered inasmuch as many of its technical aspects are considered proprietary.

Rubblization of the unmined oil shale within each void-developed retort will involve destruction of the remaining void level pillars followed by expansion of the shale strata between

4.5 Retort Development, Rubblization, Operation, and Production

.2 Retort Rubblization (Continued)

the void levels vertically into the void volume provided on such levels. Cratering methods of blasting will be used to create an oil shale rubble column of proper fragmentation and uniform lateral porosity within each retort.

Pillar Removal. Blast holes for destruction of the void level pillars will be drilled horizontally from both ends along the major axis of such pillars as soon as the slabbing and/or benching operations in the void areas on each level are completed. Boom-type drilling jumbos will be used for this purpose. Blast holes will range from 4 to 6 inches in diameter, depending on the density of the explosives used and the height and width of the pillars involved.

Drilling. Blast holes for rubblizing the shale strata between the void levels will be drilled vertically downward from both the upper and intermediate levels of the smaller Phase I retorts but from only the upper level of the larger Phase II and III retorts. These 14-inch-diameter holes will be drilled on a 23-ft-square spacing through 2/3 to 3/4 of the interval between levels. Such hole size and spacing are based on the explosive

.5 Retort Development, Rubblization, Operation, and Production

.2 Retort Rubblization (Continued)

charges interacting to produce the effect of a cratering blast. In the smaller retorts, a total of 60 and 52 holes will be drilled respectively from the upper and intermediate levels. The difference between levels represents the centermost holes in the retort which will extend from the upper level, through the large pillar on the intermediate level, and into the underlying shale strata. Blast holes will not be located in the corners of the retorts. A proportionately greater number of deeper holes will be drilled from the upper level of the larger retorts. The height of the intermediate level will permit rotary blast-hole drilling with standard self-propelled mast-type rigs, but down-the-hole percussion drills or raise-boring rotary drills may be more feasible on the upper level because of the limited head room. In either case, holes will be drilled dry using compressed air for bit cooling and cuttings removal. Dust collectors will be needed at the hole collars.

Loading. Blast holes will be charged with an explosive agent, primed with a high explosive detonator, and stemmed to the collar with inert material as soon as they have been drilled. The only exception will be the horizontal holes in the large pillar on the intermediate level which will not be charged until the vertical holes through the pillar have been drilled.

.5 Retort Development, Rubblization, Operation, and Production

.2 Retort Rubblization (Continued)

Vertical blast holes will be loaded with explosives to about one-half the thickness of the shale interval between levels. Such powder columns will be spaced in the middle of each shale interval, and detonators will be placed midway in the powder columns.

Blasting. All horizontal and vertical blast holes within a retort will be detonated in a millisecond delay sequence lasting about one-half second. Short delay intervals of 25 milliseconds will be used between the vertical blast holes because of the limited void volume provided for expansion of the shale intervals between levels. Void level pillars must be removed before these shale intervals can effectively expand into the void levels. To insure such expansion and to allow pillar ejecta time to distribute uniformly throughout the void, the pillars will be blasted at least 100 miliseconds before the shale intervals. The larger void level pillars have farther to expand to reach retort boundaries and hence will be blasted before the smaller pillars. After the pillars have been removed in the smaller three-level retorts, both shale intervals will be blasted simultaneously so as to insure equal expansion of each into the available void volume.

.0 MINE DEVELOPMENT PLAN

.5 Retort Development, Rubblization, Operation, and Production

.2 Retort Rubblization (Continued)

Explosives. Blast hole size and spacing are based on the use of an aluminized slurry explosive in the successful rubblization of the commercial-size experimental retorts at Logan Wash. The 1.34 pounds of this explosive required per ton of shale rubblized in such experiments is equivalent to 1.89 pounds per ton of ANFO.

Nearly 400,000 tons of rubble will be produced in each of the smaller retorts; and an average of more than 1 million tons in each of the larger retorts. Such production will result from the simultaneous blasting of some 536,000 pounds of slurry or 756,000 pounds of ANFO in the smaller retorts and an average of some 1.3 million pounds of slurry or 1.9 million pounds of ANFO in the larger retorts. Inasmuch as the mine is classed as gassy, a variance to the gassy mine regulations must be granted for the underground use of either explosive as well as for the quantites of such explosives to be detonated at one time in each rubblization blast. The conditions under which a variance may be granted are unknown but could involve the removal of all personnel from the mine during retort rubblization and the extensive testing of the mine atmosphere and other safety inspections before their return. A research program is ongoing to develop an oxygen-balanced explosive, the byproducts of which are not flammable and would not have the potential for post-rubblization ignition.

5 Retort Development, Rubblization, Operation, and Production

.2 Retort Rubblization (Continued)

Bulkheads. After the blast holes have been drilled and charged in each of the several retorts within a cluster, rubble blasting will commence in the centermost retort and will retreat in both directions toward the outermost retorts. Such procedure is necessary since access is available only from the ends of a cluster. After each retort in a cluster has been rubblized, a membrane-type bulkhead consisting of broken shale and shotcrete will be placed on each void level between the last rubblized retort and the next retort to be rubblized. When all retorts within a cluster have been rubblized, permanent bulkheads will be constructed at both ends to seal off the cluster from the remainder of the mine workings.

.3 Retort Operation

MIS Retorting System. Green River oil shale is neither a shale nor does it contain oil. Rather it is a marlstone containing variable amounts of a solid organic material known as kerogen which can be converted to a synthetic crude oil and other products by pyrolysis. Pyrolysis is the chemical decomposition of the material by the application of heat and is synonymous with retorting in oil shale parlance. When heated in an oxygen-free atmosphere to 700-900°F, kerogen decomposes into shale oil, light hydrocarbon and hydrogen-containing gases, and carbon. Shale oil leaves the rock as a vapor or mist that condenses to a

.0 MINE DEVELOPMENT PLAN

.5 Retort Development, Rubblization, Operation, and Production

.3 Retort Operation (Continued)

liquid when cooled. The balance of the carbon in the organic material remains in the rock as a coke-like residue.

It is the combustion of the residual carbon and some of the residual oil in the retorted shale that provides the heat for pyrolysis in the MIS retorts. Such combustion is initiated using an external fuel source to ignite the oil shale ruble at the top of the retorts and thereafter is sustained and controlled with regulated amounts of air and steam drawn into the top of the retorts and down through the rubble columns by exhaust blowers on the surface.

Retort oil yield will be reduced by thermal cracking or coking if the rate of combustion heating is too fast or too slow. Steam is supplied with the intake air to control combustion which it does by reacting with some of the residual carbon. The hydrogen and carbon monoxide produced by such reaction add to the heating value of the retort offgas product. Combustion also is controlled to some extent by thermal decomposition of the mineral carbonates in the shale to carbon dioxide and residual meneral oxides and hyroxides. A portion of this carbon dioxide reacts with the residual carbon to produce additional carbon monoxide. Free and hydrated water is vaporized, and some of the

.3 Retort Operation (Continued)

sulfur present in the kerogen and pyrite is converted to hydrogen sulfide. Some ammonia also is produced from the nitrogen in the air and in the kerogen.

The gaseous products from the various reactions in the combustion zone heat the oil shale rubble immediately below the combustion front, pyrolyze its kerogen content, and intermix with the shale oil vapor and the other gases thus produced. Continued downward flow through the rubble cools this mixture, causing most of the oil vapor and a large part of the water vapor to condense on the rubble and to drain from the bottom of the retort as a liquid oil/water emulsion. Wet oil and water fractions of this retort oil/water product stream will be separated underground and pumped to the surface process facilities. Water in the wet oil fraction will be removed to produce a pipeline-quality shale oil. Oil and ammonia in the water Fraction will be reclaimed before the water is converted to steam and returned to the mine for use in the retorting process.

The remaining gaseous products form the combustion and retorting zones, which are cooled but not condensed on the raw shale rubble, will be drawin from the bottom of the retorts and exhausted to the surface process facilities. Along with the products of combustion, pyrolysis, and thermal cracking and decompostion,

4.5 Retort Development, Rubblization, Operation, and Production

.3 Retort Operation (Continued)

this retort offgas product stream contains considerable light oil and water as entrained vapor and aerosols. On the surface, the retort offgas product stream will be cooled and scrubbed to recover its oil, water, and ammonia content. The remaining low-BTU gas will be used to fire the boilers in the surface steam plant. Sufficient steam will be produced to meet all mine, plant, and process needs and to generate virtually all on-tract electric power requirements. Boiler flue gas will be cleaned of sulfur dioxide before being vented to the atmosphere.

The combustion and retorting zones in an operating retort will advance downward in the rubble column at an average rate of about one foot a day. When these zones reach the bottom of the rubble column, the air and steam inflow to the top of the retort will be shut off. The retorted shale behind the combustion front will remain hot for a long time, and the retorting process can be shut down and restarted again by simply stopping and resuming the flow of air and steam into the top of the retort.

Because of the large blasting rounds used for retort rubblization, the integrity of the smaller pillars separating the several retorts within a cluster can not be assured; and some migration between retorts of both the inlet air and steam and the offgas is anticipated. Although the pillars around a

.5 Retort Development, Rubblization, Operation, and Production

.3 Retort Operation (Continued)

cluster are much larger and less subject to blasting damage, the retorts will be operated under slightly reduced pressures with respect to the other mine workings so as to prevent any leakage of the offgas into such workings.

Air for supporting combustion in the retorting process will be drawn from the mine intake ventilation network, and steam for controlling such combustion will be generated on the surface and passed into the mine through boreholes.

Ground water inflow into the operating retorts is expected to be minimal because of the extensive development openings provided around each retort, cluster, and panel before start-up. Such openings will intercept and drain off the water that otherwise could enter the retorts.

The temperatures reached in a MIS retort will be significantly higher than those in most aboveground retorting processes, and the oil shale rubble will be exposed to such temperatures for a longer time. Under such conditions, substantial amounts of the oxides and hydroxides formed by the thermal decomposition of the carbonates will be converted to insoluble silicates not subject to leaching by ground water. These silicate minerals generally are stronger than either the original or decomposed minerals,

4.5 Retort Development, Rubblization, Operation, and Production

.3 Retort Operation (Continued)

and thus the structural strength of the oil shale rubble will not be significantly affected by retorting. The oil shale rubble is confined between the walls of the retort, and its bulk volume also will be largely unchanged by the retorting process.

Figure 4.6 is a generalized block flow diagram of the MIS Retorting System showing movement of the liquid and gaseous product streams from the mine through the surface process facilities. Details of the surface process facilities are covered in Section 5.0.

Start-Up. Retort start-up procedures will be initiated as soon as all retorts within a cluster are rubblized, sealed off, instrumented, and otherwise ready for operation. Such procedures will involve purging the retort of air, testing the retort rubble for uniformity, and igniting the rubble. These procedures will be initiated in all retorts of a cluster within a 24-hourt period.

Start-up burners of special design will be used for both purging and igniting the retort rubble. These are reuseable pressure-atomizing-type of shale oil-fueled burners that will be lowered through the air/steam inlet holes onto the top of the oil shale

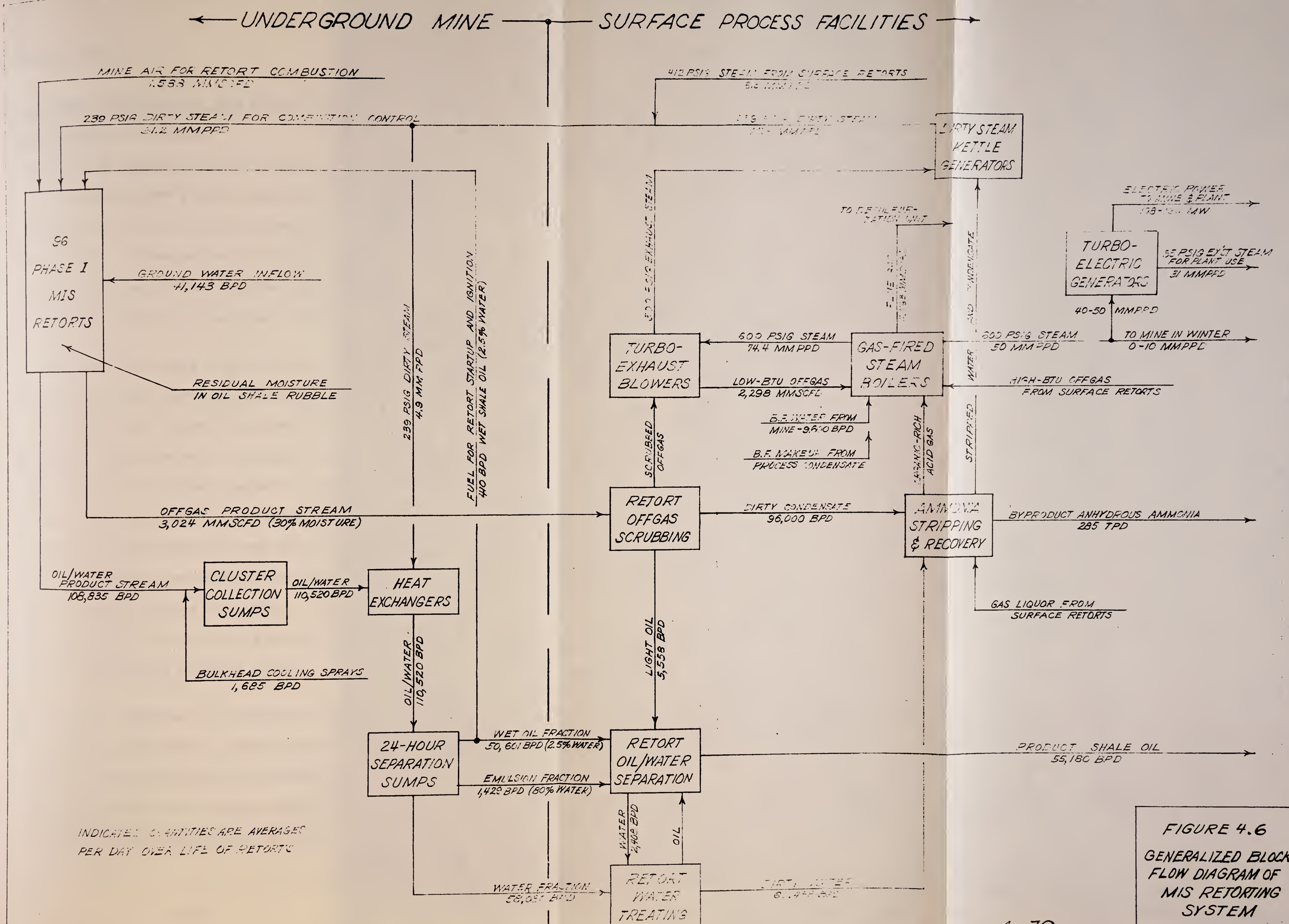


FIGURE 4.6

GENERALIZED BLOCK FLOW DIAGRAM OF MIS RETORTING SYSTEM

.5 Retort Development, Rubblization, Operation, and Production

.3 Retort Operation (Continued)

rubble. Air for combustion of the burner fuel will be supplied by small portable blowers on the Ignition level. The atomized air/fuel mixture will be ignited automatically from local control panels. Thermocouples will be provided to verify burner operation, and steam will be injected into the air/fuel mixture for temperature control of the burner flue gas.

Each retort will be purged of air prior to ignition by operating the start-up burners under regulated conditions for 24 hours. Air will be flushed from the retort by combustion gases generated by these burners. Such gases will be held to an oxygen content of less than 1 percent by regulating the air/fuel ratio for the burners and will be maintained at a temperature below 650°F by injecting steam into the air/fuel mixture. About eight hours of burner operation will be needed for a complete turnover of the gas volume in a retort. Uniformity of the retort rubble will be evaluated by monitoring pressure drops and by tracer tests during the purge cycle.

Ignition of the rubble will be started as soon as the air has been purged from the retort. Greater amounts of heat will be required to raise the rubble to its kindling temperature, and the start-up burners thus will be operated with higher air/fuel inputs and at higher temperatures for longer periods.

.5 Retort Development, Rubblization, Operation, and Production

.3 Retort Operation (Continued)

Temperatures of the burner combustion gases will be maintained below 1,800°F by injection of steam into the air/fuel mixture. Temperature, pressure, and composition of the retort offgases will be monitored to evaluate start-up performance.

Air in excess of that needed solely for burner operations will be increased in step with the capacity of the heated oil shale to consume it as reflected by the oxygen content of the retort offgases. When such excess reaches 10 percent and the resulting offgas contains less than 1 percent oxygen, the burners will be removed and combustion of the raw shale rubble will be sustained and controlled by the introduction of air and steam into the top of the retort. A bed of hot retorted shale rubble of sufficient thickness to sustain subsequent combustion in a retort will have been created after an ignition period of up to seven days.

The procedures that will be followed for retort start-up were designed to meet the anticipated MSHA operating permit requirements, including a stipulation that the oxygen content of the retort offgas not exceed 1.5 percent when the Lower Explosive Level of all combustibles in the mixture is exceeded. Instrumentation for offgas monitoring during both start-up and operation of the retorts will be located in the cluster collection drifts on the Gas level.

5 Retort Development, Rubblization, Operation, and Production

.3 Retort Operation (Continued)

Retort start-up, including purging and ignition, will require 1,218 barrels of shale oi burner fuel for each smaller Phase I retort and 2,740 barrels for each larger Phase II retort. The heating valve of the shale oil as used in the down-hole burners is 5.8 x 10^6 BTU/barrel. No oil will be consumed after start-up. Shale oil, or its equivalent, for start-up of the first cluster fo three Phase I retorts will have to be imported; but all subsequentl clusters will be started using wet shale oil (2.5 percent water) diverted from the underground separation sump for the retort oil/water product stream.

Operation. After start-up, the retorting process is sustained and controlled by the introduction of air and steam into the top of the retorts. About the same amounts of air and steam will be provided for retorting as were used in the final stages of retort ignition, and the same controls for combustion temperature and offgas oxygen content will be maintained. Under normal operating conditions, a mixture of about 70 percent air and 30 percent steam, at a temperature of some 220°F, will be supplied to the retorts at an average rate of 0.62 SCFM per square foot of their effective rubblized cross sectional area. Equivalent average input rates for each of the Phase I, II and III retorts will be 16,406, 37,971, and 41,093 SCFM, respectively. An overall average

.5 Retort Development, Rubblization, Operation, and Production

.3 Retort Operation (Continued)

of some 17,279 SCF of air and steam will be supplied for each ton of shale retorted.

Air for retorting operations will be diverted from the mine intake ventilation on the Ignition level and drawn down through the cased 6-inch-diameter inlet holes by the suction applied to bottom of the retorts by surface exhaust blowers in line with the retort offgas processing facilities. Superheated, 239 PSIG steam will be generated on the surface and transferred into the mine through boreholes from where it will be piped to the cluster drifts on the Ignition level and injected into the air flow in the inlet holes. These inlet holes will be provided with dampers to control the air inflow, and control valves will be installed in the steam injection lines. Such controls will be capable of remote operation. The flow of aire and steam into the inlet holes will be monitored with measuring devices to allow balancing of hole inflow and for total flow control.

Four distinct zones will be developed from top to bottom in the rubble column of an operating retort. The uppermost zone consists of hot retorted shale which preheats the mixture of air and steam introduced into the top of the retort. Next is a combustion zone of 1,000 to 2,000°F in which the oxygen content of the air is consumed by burning mostly residual carbon and some oil. Below the combustion front is a retorting zone where the oxygen-

.0 MINE DEVELOPMENT PLAN

.5 Retort Development, Rubblization, Operation, and Production

.3 Retort Operation (Continued)

free combustion gases heat the raw shale rubble from 700 to 900°F, and true pyrolsis of its kerogen content takes place. In the final zone, the combustion and retorting gases are cooled by preheating the raw shale rubble before they are exhausted from the retort. It is here that most of the shale oil and a large part of the water in these gases condense to a liquid and drain from the bottom of the retort.

The different zones in the rubble column of an operating retort are not clearly defined but tend to form broad overlapping layers. Ignition initially creates a thin layer of hot shale at the top of a retort that will increase in thickness as retorting progresses downward in the column, in spite of the cooling effect of the air and steam input. At the completion of the retorting process, approximately the bottom half of a retort and its burned shale rubble content will have an average temperature of about 1,000°F.

Both the retorts and the underground offgas collection network will be maintained at a slightly reduced pressure with respect to the other mine workings by means of exhaust blowers in line with the offgas processing facilities on the surface. This pressure differential not only causes the retort inlet and offgases to flow through the rubble column during the retorting

.3 Retort Operation (Continued)

process, but also prevents the leakage of such gases into the other workings. Pressure drop across a retort is a function of the superficial velocity of the inlet gases, the porosity and particle size of the rubble, and the grade of the oil shale. The higher grade shales have higher oil and gas generation rates which increase pressure drop.

Atmospheric pressure at the surface averages 11.4 PSIA but will be only a net 11.07 PSIA at the top of the retorts, some 1,300 feet lower in the mine. The pressure loss from air friction in the mine working and particularly in the retort inlet holes will more than offset the static gain from the lower elevation. Surface blowers will exhaust the retort offgas product stream from the collar of the Gas shaft at a pressure of 8.58 PSIA which is equivalent to a pressure drop of 2.49 PSIG across the retorts and the underground offgas collection network. The prorata drop across each 290-ft-high retort will be 1.69 PSIG. The average pressure differential between the top and bottom of the retorts and the occupied mine workings will range from -0.8 to -2.6 PSI. An additional pressure drop will occur across the offgas scrubbing section of the surface process facilitiies that precede the on-line exhaust blowers. Such blowers will compress the scrubbed low-BTU gas product from this section to 1.0 PSI above atmospheric pressure, or to 12.4 PSIA, for delivery to the boiler burners in the surface steam plant.

4.5 Retort Development, Rubblization, Operation, and Production

.3 Retort Operation (Continued)

The rate of retorting, and thus the life of a retort, will be controlled by the air and steam flow ratios. The overall life of each 290-ft retort, from start-up to shutdown, will average 293 days for an overall average retorting rate of slightly less than one foot a day. Optimally, the combustion and retorting zones in an operating retort should advance downward at a rate of slightly more than one foot a day. No oil will be produced during the first five days after start-up, and the optimum retorting rate will be achieved over the remaining 288-day life of the retort.

Shutdown. As the combustion zone approaches the bottom of a retort, the temperature of the offgas will increase. When this temperature exceeds 350°F, the retort will be shut down simply by cutting off its inlet air and steam. The oxygen content of the offgas normally will be very low, but severe channelling could increase its content above the anticipated MSHA limits. In such a case, the retort would be shut down in the same manner regardless of offgas temperature.

Offgas production will drop off rapidly in the first few months after shutdown, but some gas will continue to flow from the retort at increasingly slower rates over the next few years. The composition and heating value of the gas should remain fairly

.5 Retort Development, Rubblization, Operation, and Production

.3 Retort Operation (Continued)

constant. A small amount of oily water also will continue to drain from the retort, and both it and the offgas must be monitored, collected, and transferred out in the same manner as before. The production of gas, oil, and water after shutdown is the result of the long-lasting residual heat in the retorted shale rubble. Such heat continues to retort the remaining raw shale and vaporizes any ground water for reaction with the unburned carbon in the retorted shale. After all gas and liquid production has stopped, the dead retort cluster and its collection and monitoring facilities can be isolated by means of remotely controlled bulkheads on the gas level. Until such isolation, the negative pressure on the shut-down but still reactive retorts will be maintained by the surface offgas exhaust blowers. Periodic removal of any ground water drainage from the isolated dead retorts may be necessary. Periodic monitoring of conditions in such retorts also will continue.

.4 Retort Production

Retorting Efficiency. The theoretical efficiency of retorting, expressed as oil recovery, will be 65 percent of the Fischer Assay of the retort rubble. This yield is based on the best demonstrated recovery to date in the Logan Wash experimental retorts as adjusted for the higher grade oil shale on the C-b Tract and the use of steam rather than recycled offgas for retort

.4 Retort Production (Continued)

combustion control. It includes recovery losses from the failure to retort certain parts of the rubble column because of irregular flow distribution.

Oil yield will be affected by a number of operating factors including rubble uniformity, retorting rate, and retort design. Means of controlling such factors have been developed from operation of the experimental retorts at Logan Wash, but further improvements in retorting efficiency can be expected as research is continued and actual on-tract operating experience is gained.

Although retorting efficiency will remain the same regardless of the relative size of the retorts and pillars within a mining panel, the average oil yield per unit area, and thus overall resource recovery will be affected. The Phase I mining panels with their smaller retorts will yield an average of 117,820 barrels of oil per acre. Elimination of certain pillars by the larger retorts in the Phase II mining panels will increase this per acre yield to 130,910 barrels, and a reduction in size of the cluster pillars between the still larger retorts in the Phase III panels will further boost it to 182,910 barrels. The available in-place resource of the 290-ft retort horizon over the full tract contains an average of 549,374 barrels of oil per acre, and hence the overall efficiency of the proposed three-phase

MIS mining and retorting complex will range from 21.4 to 33.3 percent.

Present plans do not call for MIS retorting in areas represented by the panel and shaft pillars, and neither are reflected in the foregoing retort unit area yields. Development of additional retorts in the 300-ft-wide panel pillars, and even in some shaft pillars, may be feasible near the end of the now planned mining operations. This would not change unit area oil yield but would significantly increase overall resource recovery from the lease tract.

Products of Retorting. Two separate product streams will exit the bottom of an operating retort. These are referred to as the retort oil/water product stream and the retort offgas product stream (see Figure 4.6).

All shale oil in both product streams will come from the raw shale rubble within the retorts. No recovery from the retort walls will be considered. However, the water content of the product streams will be derived from several sources including retort inlet steam in excess of combustion control needs, humidity in retort inlet air, and ground water inflow. Smaller amounts will also be added from natural moisture (conate water)

in the rubble and from the cooling sprays activated on the pipe raise bulkheads above the cluster sumps during the closing phases of retorting. For design purposes, inlet steam will be held to 30 volume percent of the retort inlet air/steam mixture. A ground water inflow of 12.5 GPM also has been assumed for each of the smaller retorts. Both estimates may be in excess of actual need or experience. Water spray requirements will be about 15 GPM per retort cluster for about 30 days.

The percent of total oil and total water in each product stream, as well as the ratio of oil to water in both, also will vary with operating conditions over the life cycle of a retort. Peak water production and minimum oil production will occur during the first month of retort operations while the rubble is being dried out and combustion and pyrolysis are building up to normal production levels. Evaporation of ground water inflow in the still hot shut-down retorts also will switch water from the liquid to the gas stream.

Retort Oil/Water Product Stream. The retort oil/water product stream initially will evolve as oil and water vapor entrained in the hot combustion and retorting gases. As these gases are cooled on the raw shale rubble, about 90 percent of the entrained

4.5 Retort Development, Rubblization, Operation, and Production

.4 Retort Production (Continued)

oil vapor and some 30 percent of the entrained water vapor will condense to a liquid oil/water emulsion that will drain by gravity from the bottom of the retort. The oil/water product streams from all the retorts within a cluster will flow down grade to a common sump in the Gas level collection drift below the cluster. The oil/water emulsion collected in the individual sumps of the several operating clusters will be pumped to a common underground retention sump for a preliminary separation of the oil and water fractions. The oil/water product stream will leave the retorts at temperatures ranging from 70 to 350°F and averaging about 151°F over the retorting cycle. Its raw shale oil content will be free flowing down to 55°F.

Steam heat exchangers at the head of the separation sump will maintain the incoming oil/water emulsion stream slightly above 151°F so that it will remain at that temperature during the 24-hour retention period in the sump. The time-temperature-gravity separation action in this sump will produce a wet oil fraction, a water fraction, and a small interface emulsion fraction not separated within the retention period. These three fractions of the retort oil/water product stream will be pumped separately through boreholes to the surface for further processing. Such boreholes will be located adjacent to the retention sump in the Gas shaft pillar. A small portion of the wet oil

4.5 Retort Development, Rubblization, Operation, and Production

.4 Retort Production (Continued)

fraction (some 410 BPD at full Phase I production) will be diverted from the underground sump to the top of the retorts for use as burner fuel during start-up operations. Details of the underground handling system for the retort oil/water product stream are covered in Section 4.8.

The wet oil fraction from the underground separation sump will contain about 2.5 percent water and minor amounts of sludge. At full production, a net total of 50,601 BPD of wet oil, containing 49,336 BPD of oil and 1,265 BPD of water, will be delivered in a continuous stream of 1,476 GPM to the retort oil/water separation section of the surface process facilities for the mine. There, in a series of treatment steps described in Section 5.0, the water will be removed and a pipeline-quality shale oil will be produced. The water will be sent to the retort water treating section of the surface facilities.

The small oil/water emulsion fraction not separated in the 24-hour retention sump will contain about 80 percent water; and at full production, will comprise 1,429 BPD that will be pumped to the surface at a rate of 100 GPM for 10 hours a day. At the surface, the emulsion fraction is pretreated to separate the oil and water after which the oil is combined with the wet oil fraction in the retort oil/water separation section and the

.0 MINE DEVELOPMENT PLAN

.5 Retort Development, Rubblization, Operation, and Production

.4 Retort Production (Continued)

water is sent to the retort water treating section.

The water fraction of the retort oil/water product stream will contain traces of oil and sludge along with dissolved inorganic salts, soluble inorganics, and some dissolved gases such as ammonia, hydrogen sulfide, carbon dioxide, and oxides of sulfur. Inorganic salts will average about 1.3 percent by weight. (The water content of the wet oil and emulsion fractions will have about the same composition.) At full production, 58,080 BPD of such water will be pumped continuously to the retort water treating section of the surface process facilities at a rate of 1,694 GPD. There, the water will be treated in several steps described in Section 5.0 to remove the small amounts of oil and sludge and then will be steam stripped of ammonia and some of the other dissolved gases and volatile organics. The stripped water will be used without further treatment in steam-heated kettle generators to produce 239 PSIG dirty steam. Such steam will be returned through boreholes to the Ignition level of the mine where it will be used to control combustion in the operating retorts. This dirty steam also will be used in the heat exchangers at the head of the underground retention sumps. The small amount of oil recovered from the water fraction will be combined with the other separated oil products in the retort oil/water separation section.

.5 Retort Development, Rubblization, Operation, and Production

.4 Retort Production (Continued)

Retort Offgas Product Stream. The combustion and retorting gases and entrained vapors not condensed on the raw shale rubble during retorting will be drawn from the bottom of the retort, through the network of underground gas collection drifts, and up the Gas shaft to the retort offgas scrubbing section of the surface process facilities. A continuous flow of such gases will be maintained by the on-line exhaust blowers following the scrubbing and compression section. About 10 percent of the shale oil recovered from the retort wil be entrained as a light oil vapor in this wet offgas stream. The water content of the offgas will vary with retort operating conditions and elapsed operating time, and an average of 30 volume percent moisture will be used for design purposes. Offgas temperatures will range from 70 to 350°F and will average 151°F over the life of a retort. A continuous retort offgas product stream of 3,024 MMSCFD will be achieved at full Phase I production.

In the retort offgas scrubbing section of the surface facilities, the offgas product stream is cooled and scrubbed in several steps during which a total of 5,558 BPD of light shale oil and 96,000 BPD of dirty water will be condensed and removed as separate products from the stream. About 90 percent of the ammonia in the offgas will be recovered in the water condensate.

4.5 Retort Development, Rubblization, Operation, and Production

.4 Retort Production (Continued)

The light oil condensate will be sent to the retort oil/water separation section where it will join the wet oil stream from the mine and other process separated oil fractions for further processing to a final pipeline-quality shale oil. As before, the dirty condensate will be steam stripped to recover the ammonia and any suspended oil and to remove some of the other dissolved gases, after which it will be sent as feed to the steam-heated kettle generators to produce dirty steam for mine use. The recovered ammonia will be used in the byproduct recovery section to produce 275 TPD of high-quality fertilizer-grade anhydrous ammonia for market.

About 76 percent of the retort offgas product stream, or some 2,298 MMSCFD, will leave the offgas scrubbing section as a cooled and cleaned gas having a net heating value of 63 to 73 BTU/SCF. The retort offgas exhaust blowers that follow this section will deliver such gas as boiler fuel to the main steam plant. This plant will produce about 5.2 million pounds of superheated steam per hour at 750°F and 600 PSIG which will be ample to meet all mine and process needs and to generate nearly all on-tract electrical power requirements. The exhaust blowers for the retort offgas stream will be driven by steam turbines,

.4 Retort Production (Continued)

and the dirty process steam for retort combustion control will be produced in kettle generators using the exhaust steam from these turbines. Ground water inflow to the mine, which is in excess to mining needs, will be pumped to the surface and treated for use as potable water and boiler feed water. Stack gases from the steam plant will be treated with a limestone slurry to remove any remaining oxides of sulfur, and the resulting gypsum reaction product will be disposed of with the spent shale from the surface retorts.

The various surface process facilities mentioned above are indicated on Figure 4.6 and are covered in detail in Section 5.0.

Shale Oil Production. The MIS production goal for a commercial operation at the C-b Tract is 55,000 BPD. In order to meet such a goal, a minimum number of retorts of sufficient daily yield must be in operation at all times. Inasmuch as no less than a full cluster of retorts will be ignited at a time, actual production also will be governed by the number of retorts per cluster and the number of clusters in operation.

Each of the smaller Phase I retorts will have an average shale oil yield of 579 BPD; and at full design capacity, 96 such retorts in 16 clusters will be operated for an overall MIS

4.5 Retort Development, Rubblization, Operation, and Production

.4 Retort Production (Continued)

recovery of 55,580 BPD. The larger Phase II retorts will have an average yield of 1,270 BPD, and only 42 such retorts in 14 clusters need be operated for an overall recovery of 53,340 BPD. The still larger Phase III retorts will vary both in cross-sectional area and in the number of retorts per cluster. The average Phase III retort will yield 1,375 BPD, and a minimum of 40 such retorts must be operated to maintain the same level of production as in the earlier phases.

Once full production is reached, it can be maintained only by bringing complete clusters on line in a sequence depending on their productive capacity. A cluster of six of the smaller Phase I retorts must be ignited about every 18 days; and a cluster of three larger Phase II retorts, about every 22 days. In the case of the average Phase III retorts, a 5- to 11-retort cluster will be required about every 37 to 80 days. Maintaining full production will involve concurrent development of such clusters in more than one mining panel well in advance of need.

Table 4.2 summarizes the oil yields and other design parameters for each size retort together with the MIS production capacity for the three phases of mine operation now planned.

TABLE 4.2 Shale Oil Recovery and Production from MIS Retorts

Retorting Parameters	Phase I Retorts	Phase II Retorts	Phase III Retorts[1]
nal cross section of retort............FT x FT	165 x 165	165 x 380	168 x 404
ctive cross section as rubbled.............FT^2	26,461	61,244	66,279
ht of retort and rubble content.............FT	290	290	290
ctive volume of retort....................FT^3	7,673,798	17,760,856	19,220,910
me of void excavation (23%)................FT^3	1,764,974	4,084,997	4,420,809
me of shale rubbled (77%).................FT^3	5,908,824	13,675,859	14,800,101
her assay of shale rubble..................GPT	27.5	25.8	25.8
ity of shale rubbled.................Lbs/FT^3	134.9	136.3	136.3
ht of shale rubble........................Tons	398,550	932,010	1,008,627
content of shale rubble...................Bbls	260,955	572,520	619,585
retical retorting efficiency............Pct FA	65.0	65.0	65.0
yield per retort..........................Bbls	169,621	372,138	402,730
used for retort start up..................Bbls	1,218	2,740	3,045
production per retort.....................Bbls	168,403	369,398	399,685
of retort.................................Days	293	293	293
age oil yield per retort...................BPD	579	1,270	1,375
age production per retort..................BPD	575	1,261	1,364
er of retorts (clusters) at full capacity.....	96(16)	42(14)	40(4)
recovery at full capacity..................BPD	55,580	53,340	55,000
for start up at full capacity..............BPD	400	393	416
production at full capacity................BPD	55,180	52,947	54,584
l number of retorts..........................	225	202	1,378
recovery from all retorts...........Bbls x 10^6	38.16	75.17	554.96
for start up of all retorts.........Bbls x 10^6	0.27	0.55	4.19
production from all retorts.........Bbls x 10^6	37.89	74.62	550.77
age in place shale oil resource......Bbls/Acre	549,374	549,374	549,374
age oil recovery by MIS system.......Bbls/Acre	117,820	130,910	182,910
all efficiency of system..................Pct	21.4	23.8	33.3

1 Weighted average of three sizes of retorts

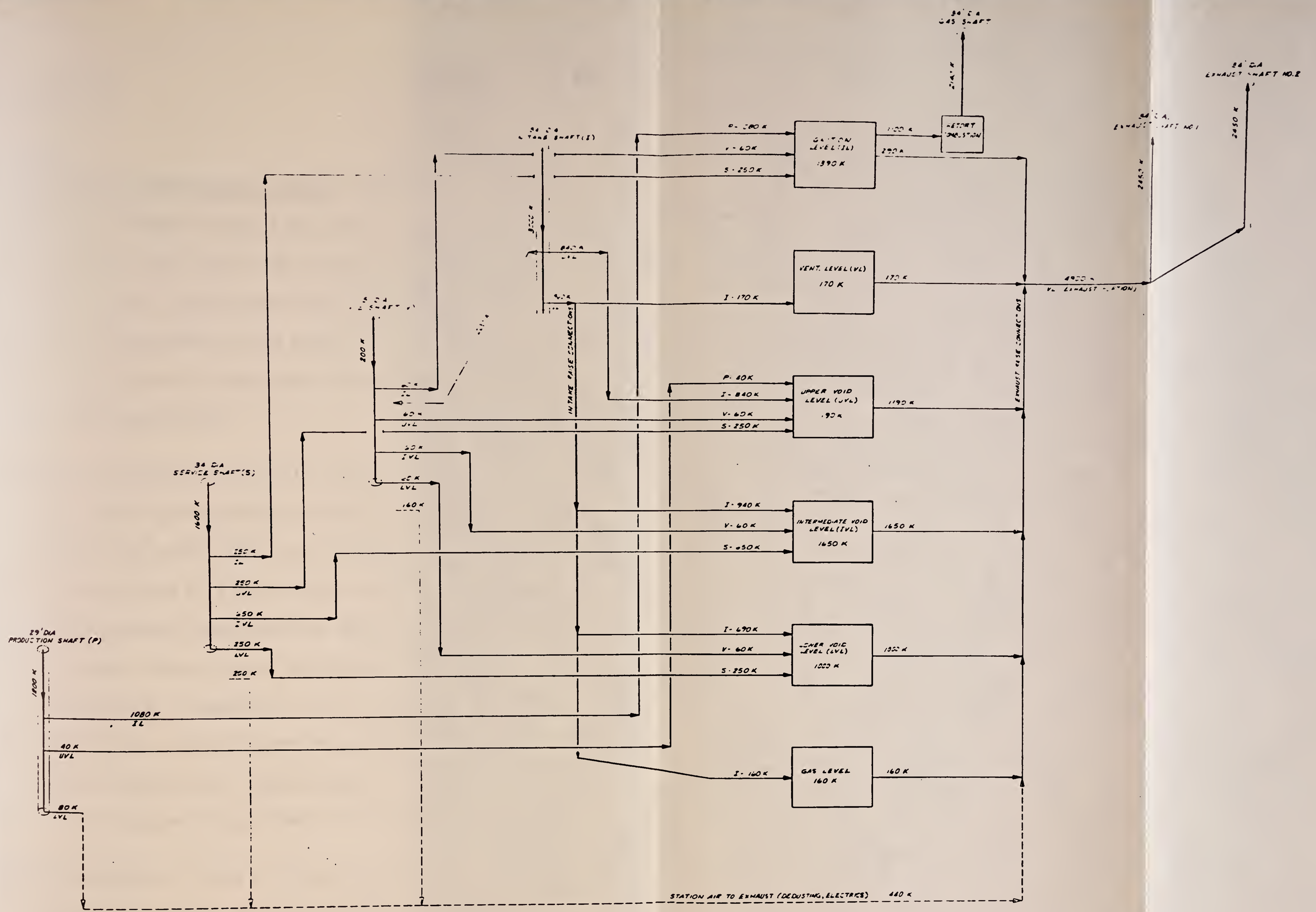
.0 MINE DEVELOPMENT PLAN

.6 Mine Ventilation

.1 General Features of Ventilation System

During full Phase I production operations, the mine ventilation system will circulate a total of 6.0 million SCFM of intake air through the Intake, V/E, Production and Service shafts. About 4.9 million SCFM of this intake air will ventilate the mine working places and the shaft level stations, and the remaining 1.1 million SCFM will be used to support combustion in the 96 operating retorts. Return air from the mine workings and shaft stations will be exhausted through a network of drifts and raises to the Ventilation level and from there to the surface through Exhaust shafts Nos. 1 and 2. Offgas from the operating retorts will be exhausted to the surface processing facilities through the dedicated Gas level and Gas shaft that are completely isolated from the other mine workings. Figure 4.7 is a schematic of the mine ventilation system showing airflow as distributed through the various intake shafts, mine levels, and exhaust shafts.

An exhaust system will be used for both mine ventilation and offgas collection and removal. The main fans for mine ventilation will be mounted at the collars of the two exhaust shafts, and the offgas blowers will be installed following the offgas processing facilities near the collar of the Gas shaft. Equal amounts of the intake air used for mine ventilation will be



NOTES:

1. ALL QUANTITIES ARE IN SCFM
2. TOTAL INTAKE - 6.0 $\bar{M}$ SCFM
   TOTAL EXHAUST - 4.9 $\bar{M}$ SCFM
   PROCESS AIR IN - 1.1 $\bar{M}$ SCFM

FIGURE 4.7
VENTILATION SCHEMATIC

4.6 Mine Ventilation

.1 General Features of Ventilation System (Continued)

returned to the surface through each exhaust shaft by means of a 5,000 to 5,500-HP axial fan having a capacity of 2.6 to 3.0 million SCFM against a water gage of 10 inches. A second such fan will be provided at each shaft for standby service. Standby electric power for these main fans will be provided by auxiliary diesel generators.

The offgas processing facilities will comprise 5 parallel gas trains each capable of handling 25 percent of the normal 2.1 million SCFM of wet offgas flow from the mine, or some 525,000 SCFM. Each such train will be provided with 2 parallel steam-turbine-driven exhaust blowers each of which will be capable of handling a normal offgas flow of 360,000 SCFM. Thus, only 4 of the 5 trains need be in operation at one time, and each train can be maintained at nearly 70 percent capacity with only a single blower in operation. Excess blower capacity in the other trains also can be used to supplement such single blower operation.

Proper distribution of intake air among the four intake shaft will be achieved by natural splitting based on the cross sectional area and internal air resistance of each. Such factors will limit the intake air velocity in the V/E, Production, and Service shafts which also must be used for man and material handling. The diversion of intake air from the shafts to the

4.6 Mine Ventilation

.1 General Features of Ventilation System (Continued)

major distribution levels of the mine will be regulated by booster fans installed in ventilation drifts by-passing the shaft stations and access drifts. Such arrangement will avoid the high air velocities that otherwise would occur in these heavy working areas. The ventilation level will be separated into intake and exhaust sections by stoppings that will be moved as development progresses and different intake/exhaust configurations are needed. Raises will distribute air both from the intake section to the levels where it is needed and to the exhaust section from the active mining areas.

Intake air normally will be used to ventilate only a single working place from where it will be coursed directly to the return air network and exhausted to the surface. Intake air will be directed through the level stations at the V/E shaft and in the Production/Service shaft area and then will be returned directly to the exhaust network. Such separate splits for station ventilation will insure that fumes from the shops and electrical substations will not enter the main intake air stream to the mine working areas.

All bulkheads in the retort areas will be provided with auxiliary fans to insure dilution and dispersion of any possible retort offgas leakage. Monitors and alarms also will be installed at

4.0 MINE DEVELOPMENT PLAN

4.6 Mine Ventilation

.1 General Features of Ventilation System (Continued)

critical locations to detect possible build ups of hazardous gases.

A series of automatic air shut-off doors will be provided at pertinent locations throughout the mine to control possible fire contaminants in the intake air streams. Such doors would close and alarms would be actuated upon sensing of specific contaminants in the mine air. Small manway doors provided within the large drift-size shut off doors would permit exit of any personnel from the affected area.

Temperatures in the mine will be regulated to a maximum of 86°F. This will be accomplished through use of evaporative coolers if the natural moisture absorbed by the mine air does not modulate its temperature. Without some cooling, mine air in the dry state could be expected to rise over 100°F. During winter months, intake mine air will be heated in order to eliminate problems of ice build up in the shafts. Excessively cold air reachng the shaft level stations and their attendant shops and other working areas also would have an adverse effect on the working environment.

.2 Ventilation During Initial Development

The ventilation system will be expanded in stages as mine development progresses. Initial development off the V/E shaft will

.7 Mine Ventilation

.2 Ventilation During Initial Development (Continued)

use that shaft as an intake, and an 8-ft-diameter raise bore to the surface as an exhaust, for up to 300,000 SCFM of ventilating air. Another interim system, using the Service shaft as an intake and the Production shaft as an exhaust, will provide ventilation for initial station development from these shafts and for the main panel drifting toward the Phase I retort area. A pair of exhaust fans with a combined capacity some 1.2 million SCFM will be installed at the Production shaft. After a connection is made between the V/E shaft and the Production/Service shaft area, the Production shaft will serve as the ventilation exhaust for all underground development operations. This system will remain in effect until the No. 1 Exhaust shaft and the Ventilation level are operational, at which time the fans will be removed from the Production shaft and it thereafter will serve as an intake air shaft.

.3 Mine Air Distribution

The amount of intake air that will be supplied to the mine working places is based on a variety of factors including gassy mine conditions, diesel equipment in use, dust and flammable gas generated, possible leakage from retort bulkheads, and air temperature and humidity in the working environment. Some of the air volume and velocity criteria used in developing the mine ventilation system are listed below.

6 Mine Ventilation

.3 Mine Air Distribution (Continued)

Minimum velocity in active areas	60 FPM
Minimum volume for diesel equipment	125 SCFM/BHP
Minimum volume at working face	6,000 CFM
Minimum volume at retort bulkheads	25,000 CFM
Minimum volume in access drifts	35,000 CFM
Maximum velocity in Production, Service and V/E shafts	2,500 FPM
Maximum velocity in main access drifts	500 FPM
Maximum velocity in conveyor drifts	250 FPM

Using the foregoing criteria, the amount of air needed for each anticipated type of mining operation was determined. The number of such operations that must be undertaken concurrently on each level to meet the planned production schedule was then used to estimate the quantity of intake air required for each level. This estimate is summarized in Table 4.3.

.4 Panel Drifting

A total of 70,000 SCFM of intake air will be supplied to the two headings of the double panel drifts. This quantity, when converted to actual CFM, produces a velocity of about 150 FPM in a drift with a cross section of 20 by 30 feet and satisfies the exhaust fume dilution requirements for 700 diesel BHP. Crosscuts spaced at about 315-ft intervals will allow one drift for air intake and the other for air return. (Such spacing will require a variance to gassy mine standards.) The last crosscut will remain open to complete the ventilation circuit and to maintain access to the advancing headings. All the other crosscuts will be provided with temporary or permanent stoppings designed to

TABLE 4.3 Volume of Intake Air for Each Mine Level

Level	Operation	Volume, SCFM x 10^3
Ignition	Air for retort combustion	1,100
	3 panel drifting units	210
	2 inlet hole drilling units	80
		1,390
Ventilation	2 panel drifting units	170
Upper Void	2 panel drifting units	140
	4 void drifting units	280
	5 void excavation units	770
		1,190
Intermediate Void	2 panel drifting units	140
	4 void drifting units	280
	5 void excavation units	1,230
		1,650
Lower Void	2 panel drifting units	140
	4 void drifting units	280
	4 void excavation units	580
		1,000
Gas	2 drifting units	160
All Levels	Shaft station splits	440
	Total	6,000

.6 Mine Ventilation

.4 Panel Drifting (Continued)

minimize leakage between the intake and return drifts. An auxiliary fan will be used with 48-inch ventilation pipe to force some 40,000 CFM of intake air beyond the last crosscut to the face of each heading.

.5 Void Drifting

After two adjoining mining panels have been blocked out by panel drifting, a pair of void drifts will be driven through each cluster of retorts within these panels. Such drifts will be advanced from both ends of the cluster and will be ventilated in the same manner as the double panel drifts. Intake air from one of the bordering panel drifts will be coursed through one of the advancing void drifts and will return, via the last connecting crosscut, through the other void drift. Return air from the void drifts will bypass the intake panel drift through an overcast and enter the second panel drift which will be connected to the Ventilation level via one or more exhaust raises. Only a short section of this second panel drift will be isolated by brattice walls for use as a return airway. After a pair of void drifts has been extended the full length of a cluster, intake air for the subsequent void excavation from these drifts will be routed in one direction through the cluster.

4.6 Mine Ventilation

.6 Void Excavation

Void excavation will involve the slabbing and benching of individual rooms up to 60 feet high and 52 feet wide from the pair of void drifts through each retort cluster. To ventilate such excavations, intake air will be coursed through the cluster, entering from the central pair of panel drifts between two adjoining mining panels and exiting into a designated return section of the panel drifts on the far side of each panel. Such air will bypass the intake section of these latter drifts through the overcasts provided for void drifting from this side of the cluster. The direction of airflow through the remaining void pillars will alternate from north to south in the adjoining retorts within a cluster. Means of directing the needed quantities of air through the various void openings has yet to be finalized, but a system of auxiliary fans and deflector curtains appears most feasible. The quantities of air needed for ventilating the void excavations on each level, based on a minimum air velocity of 60 FPM, will range from 145,000 to 246,000 SCFM. Such quantities will permit the use of diesel equipment with an aggregate of 1,450 to 2,460 BHP.

.7 Mine Water Management

Drifts on the Ignition and Void levels will be sloped so that ground water inflow to the mine will drain to intermediate collection sumps excavated at various locations along these levels. Water from these

intermediate sumps will be transferred, either by pumping or natural drainage, to mine water settling sumps located near the V/E Shaft on both the Upper and Lower Void levels. Drainage trenches and ditches along the levels and bore holes and raises between the levels will be used for such collection and transfer. Mine water inflow on or above the Upper Void level will be diverted to the settling sump on that level, while all other inflow to the mine will be handled by the settling sump on the Lower Void level.

Mine water diverted to the Upper Void level sump will be treated for the removal of suspended solids. In addition to the settling sump and its sump pumps, the mine water treatment facilities on this level will include a gravity settler with underflow pumps, a bank of four gravity filters with backwash pumps, and a mine service water sump with service water pumps. The clarified water produced from such facilities will be pumped through bore holes to all mine levels for use in drilling, muck wetdown, dust control, bulkhead sprays, pump sealing and cooling, and other mine service. The underflow of the gravity settler and the filter back wash will be pumped to the mine water settling sump on the Lower Void level.

Submersible pumps in the settling sump on the Lower Void level will transfer the mine water, including the suspended solids, to the main mine water pumping station on the Upper Void level. This station will contain five positive-displacement pumps in parallel arrangement

4.7 Mine Water Management

that will discharge the excess mine water through a 10-inch pump column in the V/E Shaft to holding ponds on the surface. A second pump column of the same size will be provided for stand by service. Additional pumps could be installed in the main pumping station should ground water inflow to the mine exceed current projections.

Any excess mine water inflow to the settling sump and treatment facilities on the Upper Void level will be bypassed to the settling sump on the Lower Void level for discharge to the surface. Mine water from the lower sump also can be bypassed to the upper sump to cover any under supply there and to maintain the needed output of treated mine service water. An 8-inch pipe column will be provided in the V/E Shaft to supply surface make-up water for mine service should the need arise.

Figure 4.8 is a piping flow diagram for mine dewatering showing the general arrangement of the collection, treatment, and pumping components.

Recent projections of total ground water inflow to the mine over the initial 14-year development phase start at 900 GPM, increase to 1,500 GPM in 2 to 3 years, and reach a maximum level of 1,800 GPM after 11 years. Some 450 GPM of such inflow will be in excess of the mine service water requirements and will be discharged to the surface. On the surface, this excess mine water will be clarified, filtered, and

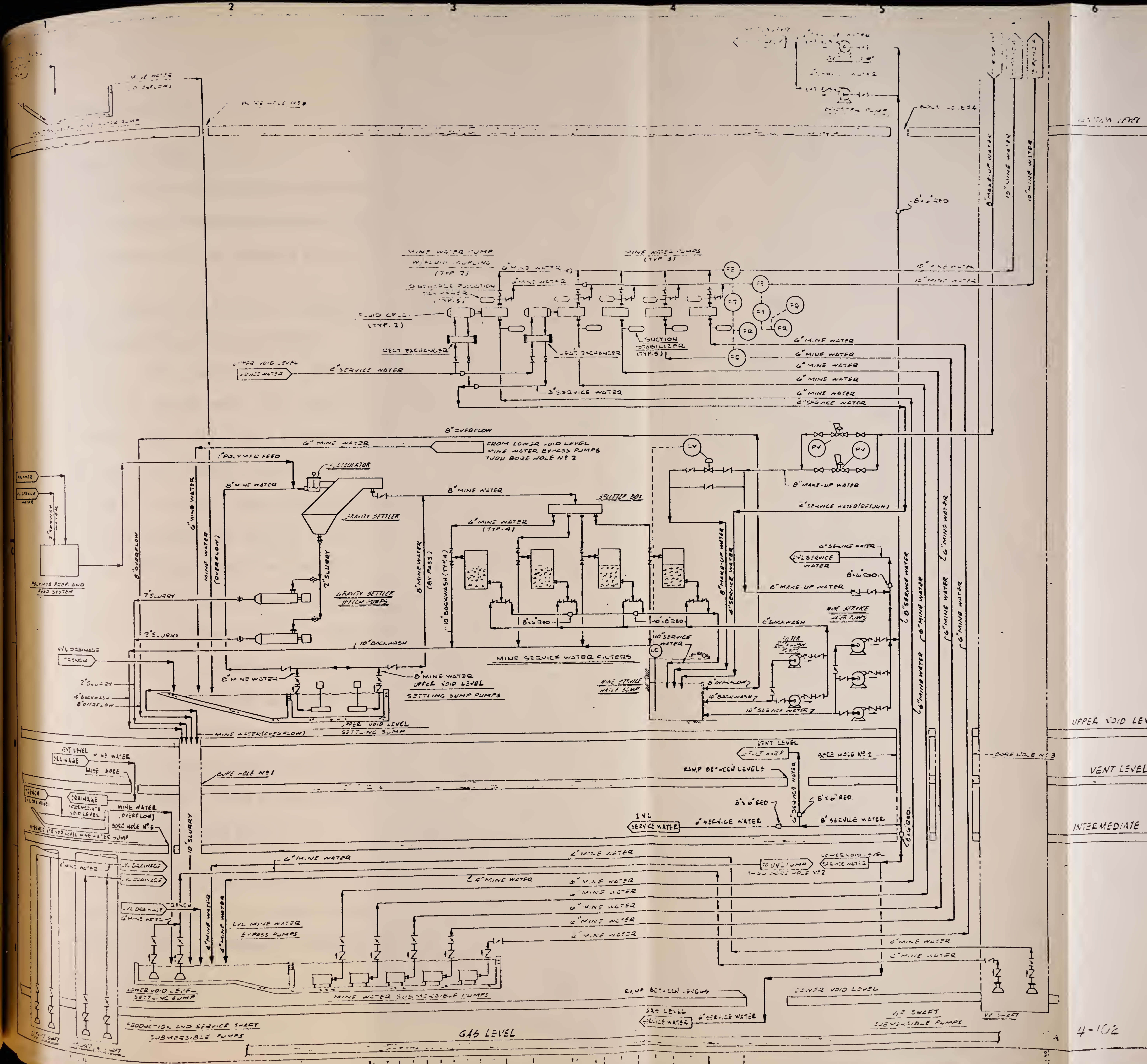


FIGURE 4.8
PIPING FLOW DIAGRAM
PERMANENT MINE
DEWATERING

4.7 Mine Water Management

desalted down to 100 ppm of total dissolved solids. Some 170 GPM of it will be further filtered and chlorinated for use as potable water, and the remainder will be softened for use as boiler-feed water.

4.8 Product Oil, Water, and Offgas Collection

.1 Retort Oil/Water Product Stream

As described in Section 4.5.4, most of the shale oil vapor and a large part of the water vapor entrained in the hot combustion and retorting gases will, when cooled on the raw shale rubble, condense to a liquid oil/water emulsion that will drain from the bottom of a retort. Such drainage will continue down through the multiple drainage and exhaust raises below the retort to the cluster collection drift on the Gas level. The oil/water product streams from all the retorts within the cluster will flow down grade in the cluster drift to a common cluster collection sump. This sump will be created behind a 10-ft-high concrete wall or dam extending across the width of the cluster drift near the junction of that drift and the primary panel collection drift. The 5 feet of open cluster drift remaining above the top of the concrete dam will allow passage of the retort offgas stream into the panel collection drift.

The oil/water emulsion collected in the cluster sump will be pumped to the Lower Void level through a pipe raise bored above the sump. Two independently operated self-priming pumps with

.8 Product Oil, Water, and Offgas Collection

.1 Retort Oil/Water Product Stream (Continued)

automatic fluid level controls and remote actuator switches will be provided for this purpose. One of these will be a standby unit for emergency service. Pump discharge pipes will extend up the raise and through the gas-tight bulkhead over its collar at the Lower Void Level. Water sprays on the underside of this bulkhead will cool it during the final stages of retort operation when the retort offgas will rise to 350°F. Water from such sprays either will be vaporized and removed with the offgas or will drain as a liquid to the cluster sump and be pumped out with the oil/water emulsion. The emulsion product pumped from the collection sumps in all operating clusters will be piped along the Lower Void level to a bank of retention sumps for preliminary separation of the oil and water fractions.

Drawings EM-107 through 110 show the layout of the cluster drifts, the cluster sumps, and the pipe raises for the retort oil/water emulsion stream.

Drawing EM-111 shows the layout near the Gas shaft of the two initial retention sumps for the preliminary underground separation of the emulsion product. Such sumps will be located 50 feet below the Lower Void level in order to provide sufficient static head for overcoming the resistance of the on-line heat exchangers to the gravity flow of the emulsion. The emulsion stream will

4.8 Product Oil, Water, and Offgas Collection

.1 Retort Oil/Water Product Stream (Continued)

leave the retorts at temperatures ranging from 70° to 350°F and averaging about 151°F over the retorting cycle. Steam heat exchangers ahead of the retention sumps will maintain the emulsion stream slightly above 151°F so that it will not drop below that temperature during the 24-hour retention period in the sumps. The dirty steam generated from retort water on the surface and piped through a borehole to the Ignition level for input to the retorts also will be used for these heat exchangers. An insulated steam line extending through a borehole from the Ignition level will be provided for this purpose. Access to the sump sublevel will be by means of inclined ramps from the Lower Void level.

Each sump will be 520 feet long, 30 feet wide, and 25 feet high; will be enclosed by gas-tight bulkhead's at either end; and will be capable of holding one-half of the daily emulsion inflow. One end will have a sloping bottom to permit access for cleanup of any settled sludge. Any retort offgas entrained in the emulsion and released during its retention in the sump will be vented through a pipeline in a borehole from the sump sublevel to the Gas level. A system for purging this gas from the sump during cleanup or any other needed maintenance will be provided. Precautions must be taken during such purging inasmuch as any oxygen introduced into the offgas could create an explosive mixture.

4.8 Product Oil, Water, and Offgas Collection

.1 Retort Oil/Water Product Stream (Continued)

Space has been reserved in the mine layout near the Gas shaft pillar for a third, or standby, sump that will allow two sumps to remain in operation while the other is being cleaned and inspected. A standby sump probably will not be needed during the early years of operation.

The time-temperature-gravity separation action in the 24-hour retention sumps will produce a wet oil fraction, a water fraction, and a small interface emulsion fraction not separated in the retention period. These three fractions will be pumped separately through boreholes to the surface for further processing. Such boreholes will be drilled within the Gas shaft pillar, far enough away to be unaffected by any possible subsidance in the Phase III retort area. A separate 12-inch cased borehole will be used for each of the wet oil and water fractions. The pipeline for the emulsion fraction will extend through a 22-inch uncased but grouted borehole that also will be used for firewater and other water service lines from the surface. Because of the extended useful life of these cased and grounted boreholes, no standby lines for the wet oil, emulsion, and water fractions will be provided. Other boreholes may be drilled later. A small portion of the wet oil fraction from the retention sumps will be diverted through a pipeline in a borehole to the Ignition level above the retorts where it will be used

0 MINE DEVELOPMENT PLAN

8 Product Oil, Water, and Offgas Collection

.1 Retort Oil/Water Product Stream (Continued)

as burner fuel during retort start-up operations. Although not particularly volatile, shale oil is a flammable liquid; and such handling and use may require a variance to Federal mine safety standards.

.2 Retort Offgas Product Stream

As described in Section 4.5.4, the retorting and combustion gases, together with the entrained vapors not condensed on the raw shale rubble, will be drawn from the bottom of the retort through the multiple drainage and exhaust raises to the cluster drift on the Gas level of the mine. Such offgas from all retorts within a cluster will follow the common cluster drift to the central pair of panel collection drifts serving adjoining mining panels. The offgas so collected from all operating clusters will pass through the network of panel collection drifts on the Gas level to the Gas shaft and up that shaft to the surface processing facilities. This offgas collection system, which is shown on Drawings EM-102, 104, 106, 108, 110, and 114, will be entirely isolated from the other mine workings.

A continuous flow of offgas will be maintained by the exhaust blowers following the offgas scrubbing section of the surface process facilities. At full production, a total of 3,024 million SCFD of retort offgas will be drawn from the mine.

4.3 Product Oil, Water, and Offgas Collection

.2 Retort Offgas Product Stream (Continued)

About 10 percent of the total shale oil recovered from the retorts will be entrained in this offgas product stream. Temperatures of the offgas will range from 70° to 350°F and will average about 151°F. To prevent deterioration from such gas, the underground offgas collection network will be lined with heat- and corrosion-resistant concrete or shotcrete.

Any blockage of offgas flow by a roof fall in the network of collection drifts on the Gas level would immediately cut off the suction created by the surface exhaust blowers on the bottoms of those retorts upstream from such fall. Without this suction, the mine air needed for retort combustion no longer would be drawn into the top of the affected retorts; and they would, in effect, be shut down. Pressure sensors in the collection drifts below each retort cluster also would actuate circuits closing both the dampers at the collars of the air inlet holes and the valves in the inlet steam lines. Offgas production from the shutdown retorts would drop off rapidly. Although leakage of large volumes of offgas at rapid rates from these shutdown retorts is unlikely, the slow escape of small quantities of gas through rock fractures and around retort seals remains a possibility. Air monitors throughout the mine will actuate alarms alerting personnel to any leakage of offgas into the occupied workings. The mine ventilation system will have sufficient capacity to dilute such gas to safe concentrations.

4.8 Product Oil, Water, and Offgas Collection

.2 Retort Offgas Product Stream (Continued)

It is unlikely that any roof fall would completely block the double entry panel drifts on the Gas level. Offgas flow would continue as long as one entry remained open, or partly so. However, the resulting added resistance to such flow could reduce suction on the upstream retorts and thus slow down their rate of retorting.

As indicated on Figure 4.6, the uninterrupted flow of offgas from the underground retorts to the surface process facilities also is dependent on the continuous operation of both the offgas exhaust blowers and the modular steam plant. Such blowers deliver the scrubbed low-BTU offgas as boiler fuel to this plant while the steam thus generated powers the turbine-driven blowers. Exhaust steam from these blower turbines, in turn, heats recovered retort water in kettle generators to produce dirty steam for combustion control in the retorts. The redundacy provided to insure continuous blower operation was pointed out in Section 4.6.1. The comparable redundany to insure continuous operation of the steam plant is detailed in Section 5.3.1 and only will be summarized here.

The steam plant includes ten high pressure modular boilers each capable of independent operation. All high pressure steam for the offgas exhaust blowers, on-site electric power generators, and other mine and process use will be produced from eight such

4.8 Product Oil, Water, and Offgas Collection

.2 Retort Offgas Product Stream (Continued)

boilers in operation. The other two boilers will serve as spares. The offgas blowers normally will require about 60 percent of the rated output of the 8 operating boilers, but near normal offgas flow and sufficient negative pressure on its collection system can be maintained with as few as 4 boilers in operation. The boilers also will be fueled by high-BTU offgas from the surface retorts as well as by the organic-rich acid gas from the ammonia recovery section of the surface process facilities. In addition, an off-site supply of natural gas will be available for startup or emergency operation of the offgas blowers. Steam for on-site electric power generation is less critical inasmuch as an alternate off-site power supply will be available.

.9 Mine Utilities

The mine utilities covered here involve those essential services and items of supply that must be continuously available for underground use but for which delivery by hoisting through a shaft is either impossible or impractical. Such services and supply items will include electric power, compressed air, mine service water, potable and fire water, sanitary sewage, low-pressure steam, diesel fuel, concrete and shotcrete, explosives, and mine communications. The utility lines for most deep mines normally are confined to the shafts--an arrangement that increases shaft down time for the maintenance of these lines as well as the air friction losses resulting from

their presence. In order to minimize such effects, present plans call for only the relatively small and trouble-free electric power and mine communication cables to be installed in the shafts. All other mine utilities will be delivered underground through pipelines extending down boreholes drilled from the surface near the Production and Service shafts. Such delivery of explosives, concrete, and shotcrete will reduce the otherwise high hoisting requirements for the Service shaft. Also under consideration is the boring of one or more small-diameter shafts in the Production/Service shaft pillar for the exclusive use of the various utility lines. Such shafts would be equipped with a work cage for the installation and maintenance of these lines.

.1 Electric Power

Electric power cables for the initial 4,160-volt and the future 13.8-Kv mine service will be extended down both the Production and Service shafts from the mine support substation on the surface. Four permissible-type 3-conductor 4/0 grounded cables will be installed in each shaft. One of the 4,160-volt circuits in each shaft will extend to a 750-Kva mine power center on the 960-ft Mid-shaft level station. The second of these shaft circuits will be used for standby service. The 440/277-volt output from the power center will extend to the temporary mine dewatering pumps as well as to a power panel on the Upper Void level

4) Mine Utilities

.1 Electric Power (Continued)

for final distribution to the initial developemnt operations on the three upper levels of the mine. The other 4,160-volt circuits in each shaft will serve a similar power center on the Lower Void level for like service on the three lower levels of the mine.

The 700-Kva power centers provided on the Mid-shaft and Lower Void levels eventually will be replaced by 13.8-Kv units capable of handling the future mine requirements. These larger units make use of all the power cables in the shaft, half of them for standby or emergency service. The original units will be reinstalled closer to the active mining areas.

The 440-volt power circuits needed for initial development off the V/E shaft will be distributed from a similar 4,160-volt power center on the Lower Void level of that shaft. This center also will be served by 4,160-volt active and standby power cables extending down the shaft from the secondary 13.8-Kv substation at its collar.

.2 Compressed Air

Compressed air for powering the rock drills on the development heading jumbos will be provided by electric-powered mobile compressor stations that will be advanced more or less in step with the development headings. Such air will be delivered to the drilling jumbos through temporary quick-coupled pipelines

4.9 Mine Utilities

.2 Compressed Air (Continued)

and flexible hoses. Similar compressor stations will be used in the slabbing and benching operations for retort void excavation. However, unless these units are approved for use in gassy mine atmospheres, they must remain in the mine intake air streams. The vertical blasthole drilling rigs for retort rubblization will be provided with their own self-contained electric- or diesel-powered air compressors. Compressed air requirements for the various maintenance and repair shops within the shaft level stations will be met by small electric-powered stationary compressors in nearby locations. The possible use of hydraulic rock drills in lieu of air drills would significantly reduce the overall compressed air requirements for the mine.

.3 Mine Service Water

Mine service water for drilling, dust control, cooling sprays, and the like will be produced from the treatment of the natural ground water inflow to the mine. The underground collection treatment and distribution system for such waters is described in section 4.7. The clarified mine service water from the underground treatment facilities on the Upper Void level will be pumped to all mine levels by means of pipelines extending through boreholes and various development openings. Mine water in excess of underground needs will be pumped to holding ponds on the surface through a 10-inch pump column in the V/E shaft. An

Mine Utilities

.3 Mine Service Water (Continued)

8-inch pipeline in the V/E shaft will supply any needed mine makeup water from these holding ponds.

.4 Potable and Fire Water

As described in Section 4.7, part of the excess mine inflow water pumped to the surface holding ponds will be treated for use as potable water in both the mine and its surface support facilities. Such water as required for mine use will be delivered to the main shaft level stations by a pipeline extending through a borehole from the surface.

Water for fire fighting on the surface and in the mine will be obtained from the mine water after its preliminary treatment down stream from the surface holding ponds. 200,000 gallons of such water will be stored in a fire water tank provided in the mine support area. It will be supplied to strategically located hydrants in the mine by a pipeline extending through a borehole from the surface. Hydrants located throughout the areas designated for the mine support facilities, the processing plant, and the surface retorts will be supplied by pipelines burried deep enough to prevent freezing during the winter months. The excess mine water stored in the surface holding ponds also will be available for fire fighting in the mine and on the surface through various interconnecting pipelines.

9 Mine Utilities

.5 Sanitary Sewage

Wastes from the sanitary facilities throughout the mine will be collected on every shift by mobile tank equipment for delivery to a common discharge sump on one or more levels of the mine. From here, such wastes will be pumped intermittently through boreholes to the surface sanitary sewage system for passage to the permanent raw sewage treatment plant located in the processing plant area near the gas shaft. A temporary sewage treatment facility will be located in the area between the Production/Service and V/E shafts.

.6 Low-pressure Steam

Low-pressure steam for controlling combustion in the underground retorts will be generated in steam-heated kettles using the impure water recovered from the retort product streams in the surface process facilities. 300 PSIG steam exhausted from the turbines driving the offgas blowers will be used for such generation. The dirty 239 PSIG steam so generated will be returned to the Ignition level of the mine for input to the retorts by means of a large-diameter insulated pipeline extending through a borehole drilled from the surface in the Gas shaft pillar. An offset borehole extending from the Ignition level to below the Lower Void level will permit the diversion of part of the low-pressure steam to the heat exchangers at the head of the 24-hour retention sumps for the oil/water emulsion stream.

4.9 Mine Utilities

.7 Diesel Fuel

Diesel fuel oil for the mobile mine equipment will be transfered from surface storage tanks in the mine support area to small single-shift supply tanks on the shaft level stations by means of pipelines extending through boreholes drilled from that area. It will be supplied to the equipment in the mine working areas by tank truck.

.8 Concrete and Shotcrete

An average of 200 cubic yards of concrete and shotcrete will be used in the mine each day. The cement, sand, and gravel for both products will be supplied from the surface batch plant in the mine support area and will be delivered to one or more of the underground levels by means of drop pipes or slick lines extending through boreholes drilled from that area. These ingredients will be delivered either as separate dry components, as a dry mix, or as a wet concrete mix. Sand and gravel for all but the wet concrete mix will be preheated in the batch plant to remove any moisture that would interfere with the free flow of the dry materials through the vertical drop pipes. Each form of delivery has its own inherent advantages and disadvantages, and the one or more that eventually will be used has yet to be determined.

Regardless of their form of delivery, the components reaching the mine levels will be loaded into standard concrete or shotcrete

4.9 Mine Utilities

.8 Concrete and Shotcrete (Continued)

mix trucks for transport to the ultimate place of use in the mine Water will be added to any dry concrete components so loaded, and mixing or remixing of the wet concrete and the dry shotcrete material will take place enroute to their place of use. Wet concrete will be poured or pumped from the trucks for placement in or behind pre-erected wood or steel forms. The dry shotcrete material in the trucks will be pneumatically applied to the surfaces of the mine openings, or to bulkheads in such opeinings, through flexible hoses. Water will be added to the dry material as it passes through the nozzles on such hoses.

.9 Explosives

Underground operations will require an average of 300,000 lbs of high explosives or blasting agents each day. About 220,000 lbs of this daily requirement will involve the aluminized liquid slurry used for retort rubblization. The remaining 80,000 lbs will consist of ANFO for mine and retort development. Such materials will be delivered to one or more of the mine levels by means of drop pipes or slick lines extending through a borehole from the mine support area. A single bore hole delivery system will be used for all levels. On the mine levels, the explosives will be loaded without delay into special handling trucks, transported to the mine working areas, and pumped or otherwise charged into the blast holes of the completed rubblization or development rounds.

4.9 Mine Utilities

.9 Explosives (Continued)

The delivery system outlined here represents the most ideal case and may undergo considerable modification before final resolution. Delivery of the explosives through boreholes not only is feasible but, because of the quantities involved, also is preferable to the alternative of hoisting through the Service shaft. However, this type of delivery may affect the explosive characteristics of the material. Underground mixing of the explosive ingredients immediately before use generally will produce a more effective and reliable product, but this option would require a variance to MSHA regulation.

.10 Mine Communications

An overall communications network will be provided to operate and monitor the underground mine and the surface facilities. In addition to the usual voice communication systems within the mine and between the mine and surface, this network will include various underground monitoring systems with alarm and/or recording capabililties for controlling the human environment, the operating retorts, and certain of the mining operations.

Telephone System. The communcations network will include a dial telephone system interfaced with the public trunk lines of the local telephone company through an automatic switchboard in

9 Mine Utilities

.10 Mine Communications (Conti"ued)

the Operations building on the surface. In addition to the various suface facilities, such telephones initially will be installed in each underground office, shop, shaft level station, and first aid station. Other locations may be added later.

Paging and Party Line System. Communications between the various mine working areas, the shaft level stations, the shaft collars, and the surface facilities also will be provided through a combined paging and party line system that will be interfaced with the telephone system through the surface switchboard. In addition to a party line telephone hand set, each local station of this combined system will contain an amplified horn-type loud speaker for voice paging of any party being called. Each such station will be battery powered for regular and emergency service. A manual means of paging all stations will be activated automatically in the event of switchboard failure. Inputs from both the mine fire alarm and blast warning systems will be provided.

Radio System. A VHF/UHF radio base station will be provided in the surface communications center with repeater stations located to cover the surface facilities and possibly selected underground operations. Any underground use of radio communication will depend

Mine Utilities

.10 Mine Communications (Continued)

on the yet to be determined effects it may have on the handling and detonation of blasting agents. Even with no adverse effects, such use will be limited largely to vehicle dispatch and maintenance along the main haulage routes. Line-of-sight transmission will be used where possible. In other cases, transmission will be through a coaxial cable that has been slotted along its length to provide radio pickup in the proximity of the cable. A control console located in the communications center and accessible from the telephone system will have coded dial access to selected underground pagers and a coded and/or voice link for mobile equipment dispatch. This underground radio system will provide two-way portable communication in addition to communication with the surface. All equipment in the system will have an emergency source of power.

Closed Circuit Television. A closed circuit television monitoring system will be provided between control stations and remote material handling locations. Such monitoring initially will include conveyor belt discharge, skip loading and dumping, shaft collars, mine water collection sumps, and main pumping stations. Other operations for such control and/or security monitoring systems may be added later.

Mine Utilities

.10 Mine Communications (Continued)

Blasting Alarm System. Visual and audible alarms will be used to warn mine personnel that blasting is imminent. Whenever possible, circuits of the other underground alarm systems will be used for this purpose. The blast warning alarm will be actuated by the person in charge of setting off the blast.

Life Support System. The life support system will monitor for fire, mine air quality, flammable and toxic gases, and other conditions affecting personnel safety and the human environment. This system also will monitor the operating status and availability of all equipment for which shut-down or failure could adversely affect mine personnel and facilities. Detectors of various types will be located to monitor all working areas of the mine and will report the status of such areas to local monitoring stations and to a master control panel. The panel will be manned at all times. Alarms generally will be actuated automatically by such detectors when the life support conditions in an area reach predetermined limits. Such alarms will involve visual, auditory, or olfactory warnings, depending on local conditions. Two levels of warning usually will be provided. A fire alarm will actuate automatically upon detection of a fire in its early stages. In some areas, such detection will activate fire suppression devices. Automatic fire suppression devices

4.9 Mine Utilities

.10 Mine Communications (Continued)

independent of the fire alarm system also will be used to protect certain equipment.

In addition to monitoring conditions and actuating alarms, the life support system will be capable of controlling equipment such as air doors, fans, and electric power feeders. It also will be capable of being programmed to perform certain control functions under specific conditions and will have the ability to modify such programs as conditions change. The system will be provided with the necessary redundancy and independence of the mine electric power. Output from the life support monitors will be fed to the main safety office as well as to a master computer center on the surface that will be used for recording, analysis, and planning all aspects of the overall operations.

Retort Operation and Control. Each cluster of retorts will be instrumented to monitor its air and steam inputs as well as the temperature, pressure and composition of its offgas stream. The output from such instrumentation in each operating cluster will be fed to a local underground computer center for monitoring, analysis, and manual control action as necessary. A single computer located in a mobile trailer house also will serve other operating clusters in the same area. The data input to the underground computers will be passed to the master computer center on the surface.

4.9 Mine Utilities

.10 Mine Communications (Continued)

Mine Signal Systems. Individual, local, and area signal systems will be provided for the various operating conditions in the mine. The signals or alarms for such systems will not duplicate those of existing systems.

All mobile or remotely-controlled equipment will be provided with both visual and audible alarms that will be actuated for a set time before such equipment is moved.

A traffic control system involving traffic lights and two-way radio communications will be established for mine haulage equipment.

Two methods of signaling between each shaft level station and the hoist control rooms will be provided for moving the man-and-materials cages in the shafts. One of these will involve a telephone or intercom system. A separately-wired belling system also will be provided as backup for signaling.

Operations Monitoring. It is expected that most, if not all, of the more important underground operations also will be monitored on a continual basis at strategic locations throughout the mine. The information so collected will provide input to the master

) Mine Utiities

.10 Mine Communications (Continued)

computer for immediate operational control as well as for future analysis and planning by management.

10 Mine Equipment

The major items of mobile underground equipment required for full production operations in the mine are itemized in Table 4.4. All equipment that may be used in development headings beyond the mine intake air flow through the last open crosscut will be an approved permissible type for operation in gassy mine atmospheres. All diesel-powered mobile equipment, regardless of area of operation, will be provided with exhaust gas scrubbers and fire suppression devices.

TABLE 4.4 Mobile Mine Equipment

Item of Equipment	Units
2-Boom Drill Jumbo w/Hydraulic Rock Drills	23
Drill Rig for 8" ignition holes	3
Drill Rig for 14" rubble blastholes	13
Longhole Drill Rig for void pillar blastholes	4
Slabbing Drill Rig for void excavation	10
Benching Drill Rig for void excavation	5
Raise Borer	4
Primer Supply Truck	3
ANFO Supply Truck	27
ANFO Blasthole Loader	12
Slurry Supply Truck	10
Loose Rock Scaler	10
Boom-type Rock Bolter	10
Shotcrete Placer	8
Shotcrete Supply Truck	10
6-CY Concrete Mixer Truck	10
2-CY Front-end Loader	7
4-CY Front-end Loader	5
6-CY Front-end Loader	8
2-CY Load-Haul-Dump	15
8-CY Load-Haul-Dump	30
13-CY Load-Haul-Dump	30
35-Ton End-dump Truck	18
50-Ton End-dump Truck	14
Feeder-Breaker	12
Haulageway Grader	8
Manlift Truck w/Basket	8
Utility Truck	30
Diesel Fuel Supply Truck	7
Mechanical Service Truck	29
Lubrication Service Truck	4
1-1/2-CY Backhoe	5
5-Ton Carry-Jack Crane	8
18-Ton Crane w/Hydraulic Boom	4
Fork Lift	6
Personnel Carrier Truck (24-Passenger)	30
Boss Buggy	30
Fire Truck	5
Ambulance	4
Sanitary Service Truck	4

.0 MINE DEVELOPMENT PLAN

.11 Raw Shale Material Handling System

A system of belt conveyors on the Lower Void level will transport all raw shale recovered from mine and retort development to the Production shaft for hoisting to the surface. Rock broken in the development headings on the upper mine levels will be hauled by diesel-powered trackless equipment to raises for transfer to the Lower Void level. On the Lower Void level, rock from the transfer raises, as well as from the development headings on the Lower Void and Gas levels, will be hauled by similar equipment to strategically located feeder-breakers where it will be reduced to a minus 8-inch size before being discharged onto one of the primary or secondary conveyors belts for transport to the shaft. The belt conveyor haulage system is described in section 4.11.1.

The belt-loaded raw shale from the feeder-breakers in the mining area will be conveyed along the Lower Void level to either of two 5,300-ton-capacity storage bins at the Production shaft. Each of these trench-type bins will be filled by a traveling stacker and will be reclaimed by a conveyor belt fed from a bank of overhead apron feeders. The reclaim belt will extend to a pair of measuring flasks in the shaft below the level. Such flasks will alternately load the pair of 52.5-ton-capacity muck skips that will be hoisted in balance by one of the two identical friction hoists in the surface headframe tower. The hoisting facilities in the Production shaft, which are covered in section 4.3.5, will have a design capacity of 60,000 TPD. Figure 4.9 shows the general arrangement of the raw shale handling facilities at the Production shaft on the Lower Void level.

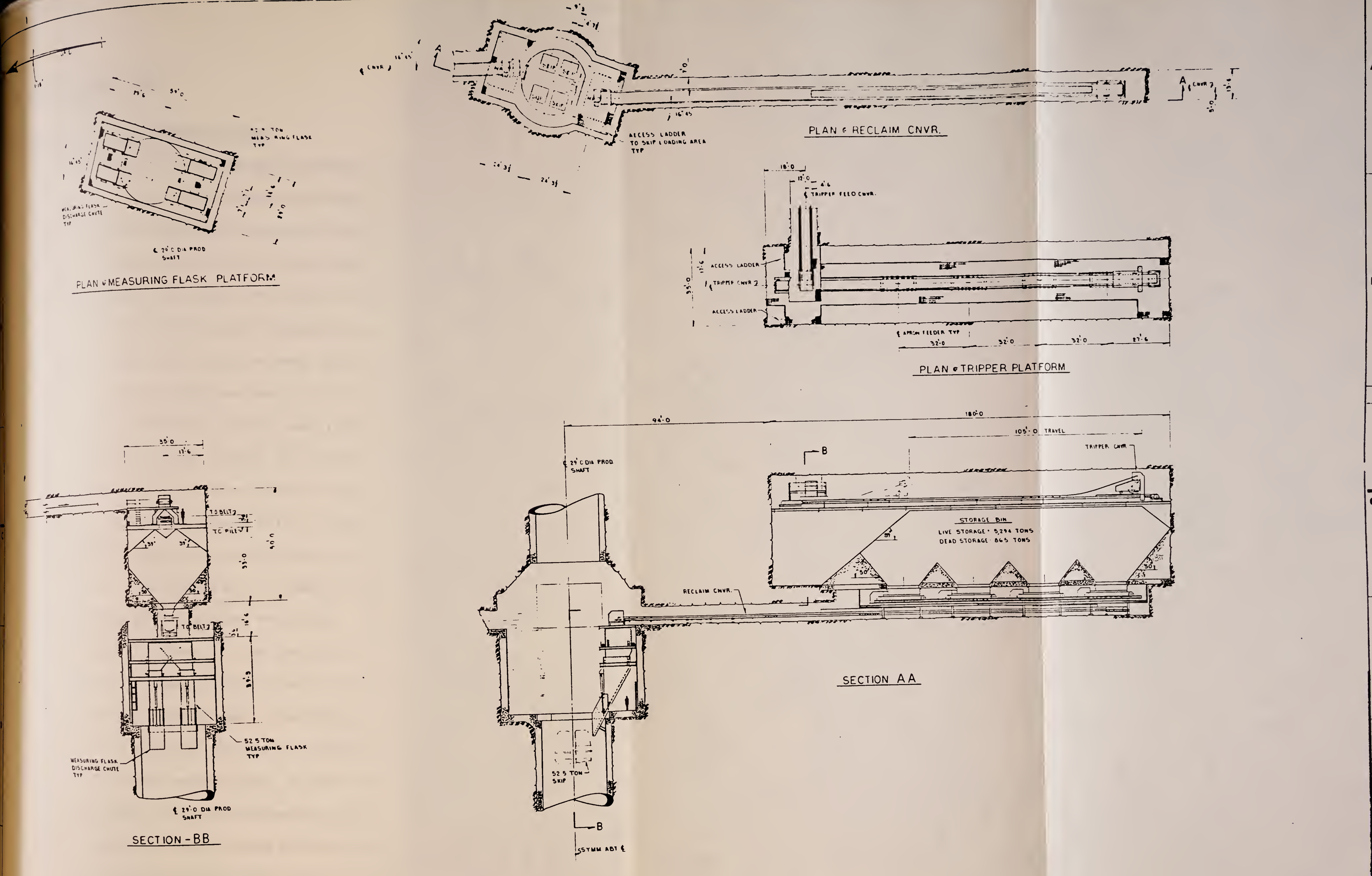


FIGURE 4.9

SKIP LOADING SYSTEM PLAN FOR PRODUCTION SHAFT

4.0 MINE DEVELOPMENT PLAN

4.11 Raw Shale Material Handling System

The 56,000 to 59,000 TPD of raw shale produced from mine and retort development will be hoisted through the Production shaft to the surface for either immediate or eventual processing in the surface retorts. All such shale will be hoisted from the Lower Void level of the mine and dumped into one or the other of the 800-ton-capacity surge bins in the Production shaft headframe tower. Apron feeders will draw the shale from such bins onto covered conveyor belts for transport to a pair of 300-ton-capacity truck loadout bins and a conveyor transfer terminal situated some 1,500 feet east of the shaft. From this combined loadout and transfer unit, the mine development rock will be either hauled by truck to the raw shale stockpile or conveyed on covered belts to the coarse shale storage structure that precedes the crushing and screening facilities for the surface retorts. No attempt will be made to segregate any low grade development shale before surface retorting. The 100,000-ton-capacity enclosed storage structure for the surface retorts will be located about 1,800 feet southeast of the transfer terminal and near the collar of the No. 1 Exhaust shaft. The 260-acre raw shale stockpile area will fall in the lower reaches of Cottonwood Gulch about 2,200 feet northeast of the loadout bins. A runoff and seepage control dam will be built across this gulch below the northern edge of the stockpile. Drawings EM-119 through EM-128 show the general arrangement of the raw shale handling facilities on the surface.

40 MINE DEVELOPMENT PLAN

411 Raw Shale Material Handling System

Raw shale will be hauled to the stockpile area in off-highway end-dump diesel trucks of 120-ton-capacity. Mobile earth moving equipment will be used to shape the pile after which it will be compacted and stabilized with an environmentally acceptable chemical agent. Belt conveyors eventually will be substituted for truck haulage of the raw shale to the stockpile and for the subsequent reclaiming of such shale for surface retorting.

Before the surface retorts are individually brought on the line, all raw shale production from the mine will be stockpiled; but thereafter, only such production in excess of the on-line retorting capacity will be added to the stockpile Retorting capacity ultimately will exceed mine production, and the shortfall will be made up by drawing from the stockpile. Such drawdown will start in about 1990 and will continue until the 43 million-ton stockpile has been fully reclaimed near the end of mining operations on the tract.

.1 Mine Belt Conveyor Haulage System

Drawing EM-115 shows the belt conveyor haulage system on the Lower Void level as arranged for Phase I operations. The main haulage belt will be located along the central-most pair of east-west panel drifts from which the Phase I mining panels will be developed concurrently to both the north and south. This main belt transfers onto a north-south belt in the pair of panel

4.11 Raw Shale Material Handling System

.1 Mine Belt Conveyor Haulage System (Continued)

drifts on the east side of the Production shaft which in turn feeds either of the belts extending directly to the storage bins at that shaft. In order to reach full Phase I production and to complete Phase II panel development to the tract boundaries, similar main haulage belts will be located in each succeeding north and south pair of east-west panel drifts.

The main east-west haulage belts will be fed by extendible-type conveyor belts in the north-south panel drifts. Brocken rock from the development headings and the transfer raises will be hauled to feeder-breakers for size reduction and then will be conveyed on these secondary panel belts to the main haulage belts. As mining advances toward the property boundaries, the initial panel conveyors will be extended and the feeder-breakers will be advanced so as to maintain a more or less constant haulage distance from the retorts under development. When retort development has advanced about one-third of the length of a panel, additional feeder-breakers and secondary panel conveyors will be installed form the opposite ends of the north-south panel drifts. These latter belts will be shortened as development advances. Such arrangement will double the haulage capacity out of any panel and will permit continued full production when a panel belt or feeder-breaker is out of service.

) MINE DEVELOPMENT PLAN

1 Raw Shale Material Handling System

.1 Mine Belt Conveyor Haulage System (Continued)

Oil shale excavated in the development of the upper levels will pass through transfer raises to the conveyor haulage level where it will be picked up and carried by LHD's, or similar self-loading transports, to the nearest feeder-breaker for size reduction and belt loading. Feeder-breakers will be positioned close to the transfer raises which will be bored along the panel drifts in step with cluster development. Such raises not used for rock transfer will serve as intake and return airways between the working places and the Ventilation level.

Three main haulage belts, each 60 inches wide by 5,056 feet long and powered by a 350-HP electric motor, will be provided for initial panel development. Some seven other 60-inch belts of various lengths and horsepower also will be used to connect these main haulage belts with the storage bins at the shaft. In addition, twelve 100-HP extendible-type secondary conveyors, each 36 inches wide and 1,650 feet long, will be used with twelve 400-HP feeder-breakers. All discharge and transfer points along the belt conveyor system will be enclosed and equipped with dust collectors.

12 Surface Support Facilities

Most of the surface support facilities for the underground mining and retorting operations will be clustered around the collars of

.2 Surface Support Facilities

the adjacent Production and Service shafts--largely within a radius of some 500 feet from each shaft. Underground excavation within this area will be restricted to the common shaft level stations. The surface process facilities for the various MIS product streams and the surface retorts for the raw shale production will be centered around the Gas shaft nearly a mile southeast of the mine support facilities. Drawing EM-131 identifies and shows the general arrangement of the major structures and other features of the mine support facilities in the immediate vicinity of the Production and Service shafts. Function of the support facilities so identified are generally self-explanatory. The relationship of the mine support facilities with respect to the surface process and retort facilities are shown on the plot plans in Drawings EM-119 through EM-128.

In so far as feasible, the surface structures of the mine support facilities will be painted and the support area grounds will be landscaped to blend into the surrounding countryside. Electric power from the mine support substation will be distributed to both shafts and to various structures and facilities within the main support area through a network of buried ducts. The main access roads on the tract, as well as those within the immediate mine support area will be paved to reduce fugitive dust from the anticipated heavy traffic.

The mine support facilities around the Produciton and Service shafts will cover an area of eighty acres, about two-thirds of

.12 Surface Support Facilities

which will be enclosed by a security fence. Guardhouses will be provided at the entrance gates in this fence. Only the two holding ponds for mine water and the employee and bus parking lots will be immediately outside the security fence. Fences for excluding livestock and wildlife will be provided around the holding ponds. An explosives storage magazine for mining operations will be located in an isolated area about one-half mile north of the main mine support facilities. The magazine also will be enclosed by a security fence with a locked gate. Temporary sewage treatment facilities for the early mining operations will be provided in the same general area. These also will be fenced. The permanent changehouse, hoist house, electric substation, and other support facilities provided for sinking operations in the V/E shaft will be retained for the initial mine development that will be carried out through that shaft. Mine air heating facilities will be provided at the collar of the Intake shaft that ultimately will be completed adjacent to the V/E shaft.

A hazardous waste retention/disposal area will be provided on the tract at a location yet to be determined. It will be fenced, patrolled, routinely inspected, inventored, and otherwise maintained in accordance with RCRA regulations.

Mine personnel will be transported from the local town to the site by bus. Buses will unload on a service road at the front of the Operation building, and personnel will enter the changehouse facilities

12 Surface Support Facilities

on the second floor of this building over a flight of stairs. Underground personnel will leave these facilities through a manway tunnel to the Service shaft and will board the man cage from the subcollar level in the headframe tower.

Diesel fuel for the mobile mine and surface equipment will be delivered to the site in tanker transport trucks and transferred to the fuel storage tanks provided in an isolated section of the fenced support area. 168,000 gallons of such fuel, or about a 7 to 10 day supply, will be stored here. An earth embankment around the immediate storage area will contain the contents of these tanks in the event of their rupture, leakage, or accidental overfilling. Under the environmental stipulations of the lease, the containment capacity so provided, must equal 110 percent of largest (42,000-gallon) tank, plus the volume below embankment height of all other tanks, plus the maximum possible precipitation and runoff within the containment area. Fuel will be delivered undergound to small single-shift supply tanks in the shaft level stations through boreholes from the surface.

Some 1,500 tons of cement and 3,000 tons each of fine and coarse aggregate, representing about a weeks supply of concrete and shotcrete for the mine, will be stored at the surface batch plant. The cement and aggregate will be mixed on the surface and delivered underground through boreholes. Whether water for the concrete will be added to the surface or underground has yet to be determined.

.2 Surface Support Facilities

The fire water tank adjacent to the fire station in the support area will have a capacity of 200,000 gallons and will be connected to strategically located hydrants both in the mine and in and around the various support facilities on the surface. The excess mine water stored in the surface holding ponds also will be available for fire fighting either underground or on the surface through permanent pipelines interconnected to the fire water supply system.

Offsite electric power from the local electric association will be delivered to a switch yard inside the north boundary of the tract where it will be stepped down from 138-Kv to 13.8-Kv and transmitted on overhead lines along the designated power corridor to the mine support substation just east of the Production and Service shafts. This substation will serve as the main power distribution center for tract operations, and both the standby diesel-powered generators and the eventual steam-powered generating plant will be interconnected with it. The latter plant will be located with the surface process facilities near the Gas shaft and will be connected by about a mile of overhead transmission line along a second designated power and utility corridor. A third designated corridor extending to the south boundary of the tract will provide for a future tie in, or connecting loop, with the regional power grid.

The 13.8-Kv power input to the mine support substation will be supplied directly to the mine through both the Production and

Surface Support Facilities

Service shafts, to the large friction hoists in the headframe tower of the Production shaft, to the main ventilation fans at the exhaust shafts, and to secondary substations at the V/E shaft and the surface process facilities. This incoming power will be stepped down to 4,160 volts for use by the small friction hoist in the headframe tower for the Service shaft, the temporary ventilation fans at the Production shaft, and the surface conveyors for the raw shale production. Separate 4,160-volt lines also will be extended down the Production and Service shafts for temporary mine dewatering service and initial mine development. Similiar 4,160-volt circuits for temporary dewatering, initial ventilation and development, and hoisting service will extend from the secondary substation at the V/E shaft. The incoming 13.8-Kv power also will be converted for 480-volt service to the various surface buildings and other support facilities both in the Production/ Service shaft area and at the V/E shaft.

Raw sewage from the mine will be pumped through boreholes to a surface sanitary sewage system. All sanitary wastes collected by such system will pass to a permanent sewage treatment plant incorporated with the surface process facilities near the Gas shaft. Treatment in this plant will involve aeration, settling, clarification, filtration, and chlorination. The treated discharge water will be used for dust control and compaction during surface disposal of the processed shale waste from the surface retorts. Sludge from the plant will be disposed of by incineration.

4.10.12 Surface Support Facilities

Other significant mine support functions will be provided by the various surface process facilities. Such functions were covered in the preceding sections on Retort Production and Mine Water Management and merely will be summarized here. Water recovered from the retort product streams will be converted to the low-pressure steam needed to control combustion in the underground retorts and to maintain the temperature of the retort oil/water emulsion product during its retention in the underground separation sumps. Excess mine water will be treated to produce both boiler-feed water for the surface steam plant and potable water for the mine and its surface support facilities. High-pressure steam from the offgas-fired boiler plant will be used to generate most of the onsite electric power requirements. Steam from this plant also will be used for driving the retort offgas exhaust blowers, for space heating in the surface support structures, and for heating mine intake air during the winter months. Natural gas will be provided for these latter heating requirements until the steam plant is operational.

4.10.13 Mine Safety

The planned development and operation of the underground mine as described in previous sections will involve the combined effort of many people working in coordinated fashion, and human safety and health considerations will be given highest priority. Working conditions will be maintained as free from recognized hazards as

.3 Mine Safety

modern industrial practice can make them, and concerted efforts will be made to prevent accidents and occupational diseases.

.1 Safety and Health Programs

Comprehensive safety and health programs will be implemented under the responsibility of a Safety Director who will serve as a member of the management team. Such programs will be formulated around the rules and regulations as established by the Federal Mine Safety and Health Administration and the Colorado State Bureau of Mines for gassy metal and nonmetallic underground mines. An adequate staff of safety personnel and industrial hygienists will be maintained for safety inspections, training, and health controls. Safety personnel will assist mine supervisors in monitoring all underground operations, work methods, and controls to develop procedures for minimizing the the potential for accidents caused by human error and equipment failure.

A safety committee of mine employees will meet regularly with management to review operation of the safety and health programs and to make recommendations on specific problem areas. Mine supervisors and department heads will hold regular safety meetings with their personnel to review committee recommendations and departmental safety concerns.

New employees will be indoctrinated with the safety rules and regulations established for mine and surface operations and

3 Mine Safety

.1 Safety and Health Programs (Continued)

their responsibility for the prevention of on-the-job accidents. Supervisors will participate in frequent safety and health training which will emphasize the safety aspects of their specific jobs as well as their key role in a successful safety program. Instruction in first aid and accident prevention methods will be provided to all employees, and selected personnel will be trained in mine rescue operations.

A comprehensive industrial hygiene program will be established to detect any unexpected occupational health effects due to working in the mine. Each new employee will be given a complete pre-employment physical examination, and a complete medical and occupational history will be maintained for each. Follow up examinations will be given at regular intervals. Employees will not be assigned to work areas where exposure could aggravate their existing conditions.

.2 Potential Safety and Health Hazards

Potential safety and/or health hazards are associated with virtually all the underground operations covered in previous sections. The more significant of these are pointed out below, together with some possible means for their control.

Mine Safety

.2 Potential Safety and Health Hazards (Continued)

Dust. Exposure to respirable dust containing free silica is a recognized health hazard resulting in occupational silicosis. The raw shale dust that will be generated by most mining operations will contain at least some free silica in the respirable size range and therefore must be controlled. In high concentrations, such dust not only will reduce visibility but also may be explosive under certain conditions. It is expected that present MSHA standards for silica dust exposure can be met through such normal control measures as adequate ventilation, wet drilling, water sprays, and collectors or enclosures on dust generating equipment. All underground employees will be provided with approved respirators to be carried at all times for emergency use. Ambient dust concentrations will be contiouously monitored by air sampling devices at various locations throughout the mine so that high concentrations can be detected quickly and control measures initiated.

Noise. Exposure to high noise levels for extended periods is a recognized health hazard for which mandatory MSHA standards also have been established. Certain mining operations are inherently noisy. Most of the noise in such operations originates with the equipment in use and often can be reduced by design

.3 Mine Safety

.2 Potential Safety and Health Hazards (Continued)

changes or by the addition of mufflers or sound insulation. Where such action fails to reduce the noise to permissible levels, personal protection equipment will be provided. Noise levels and exposure times will be monitored and recorded, and hearing tests will be given periodically to all exposed employees.

Carinogenic Risk. Potential carcinogenic risks may occur in prolonged exposure to retorted, or processed, oil shale. However, in the underground MIS process, such material is completly sealed in the retorts at all times and is never encountered by mine personnel. Shale oil, which may have similar exposure risks, will be present only in the fully isolated product streams from the underground retorts.

Explosive Handling. Explosives and blasting agents, as well as primers and detonators, will be stored in approved magazines on the surface and will be delivered into the mine only in quantities needed for immediate on-shift use. Thus, no large amounts of any of these potentially hazardous materials need be stored in the mine. The small quantities that may not be consumed during a shift will be stored for use on the following shift in trailer-mounted magazines of approved construction parked in isolated areas of the mine.

.3 Mine Safety

.2 Potential Safety and Health Hazards (Continued)

Mine Explosions. Possible sources of uncontrolled explosions in the mine include methane gas and oil shale dust. Although the mine will be gassy, the amount of methane produced should be relatively small and readily controlled by adequate ventilation. Automatic and manual monitoring for such gas will permit the shut down of operations and the evacuation of personnel long before its lower explosive limit is reached. All mobile equipment that will be used beyond the intake air flow through the last open crosscut will be rated as permissible for use in gassy mines. Concentrations of dust from the higher grades of oil shale can possibly explode when ignited by a high temperature flame such as would be produced by a methane ignition or explosion. Dust control by the means previously discussed will keep such concentrations well below their explosive limit. Keeping any methane in the mine air well below its explosive limit also will eliminate this most likely source of ignition for the dust.

Rock Falls. Falls of rock from the roof or back of mine openings are not uncommon, particularly in bedded deposits where large unsupported areas are excavated. Such falls are hazardous to both personnel and equipment. Careful design of the mine openings and monitoring of roof behavior generally will enable

3 Mine Safety

.2 Potential Safety and Health Hazards (Continued)

safe operations. Equipment can be designed to afford some rock fall protection to the operators. Scaling loose rock from the back and ribs of a mine opening after blasting also will reduce the hazard. Openings that must be used for more than short periods will be rock bolted on a pattern to be determined by experience. Metal chanels and/or wire mesh will be bolted to the back and ribs where rock fracturing is pronounced, and shotcrete will be applied to the bolted and meshed surfaces in more extreme cases.

Illumination. Adequate illumination is essential to safe underground operations, and standards for it are provided in the Federal and State mining requlations. Individual battery-powered cap lamps will be carried by all underground personnel working in the otherwise unlighted sections of the mine. Mobile mining equipment will have self-contained lighting systems to illuminate the working area for safe operation. Portable flood lights may be required in the larger void excavation areas. The various shops, offices, warehouses, and other facilities on the shaft level stations will be continously illuminated by explosion-proof lights connected to the mine electrical power network. Emergency lighting will be automatically activiated in the event of a power failure. Pump stations and other facility installations throughout the mine also will be permanently lighted.

3 Mine Safety

.2 Potential Safety and Health Hazards (Continued)

MIS Retorting. Federal and State regulations prohibit the use of fires and flammable gases in underground mines. However, a variance to these regulations may be granted when such use is strictly controlled and adequate safety precautions are taken. In the prototype operations at Logan Wash, pyrolsis of the oil shale rubble in the underground retort chambers has been carried to completion; and the offgases therefrom have been monitored, measured, and prevented from entering the other underground workings used by mine personnel. The present mining plan is based on the experience at Logan Wash and other prototype oil shale mines as well as on the various conditions under which any needed variances to present mine health and safety standards may be granted.

The retorts and their network of product collection drifts will be completely isolated from the other mine workings. Pressure drops across each retort will be monitored during the pre-ignition purging cycle, and any leakage then apparent will be evaluated. Only major leaks that could adversely affect retorting or mining operations will be sealed, either by grouting or other means. Techniques for installing leak-proof bulkheads have been developed. The slightly negative pressure that is maintained on the retorts and their product collection drifts by the surface exhaust blowers also will prevent any offgas leakage

Mine Safety

.2 Potential Safety and Health Hazards (Continued)

from the system. Under these conditions, the possibility of any retort offgas entering the mine work areas will be remote. Nevertheless, sufficient excess mine ventilation will be provided in the main panel drifts to dilute any possible gas leakage to a safe level. Auxiliary blowers also will be maintained on a stand by basis at all bulkheads in the retort area to insure dilution and dispersion of any offgas leakage. Gas monitors will sample the air at strategic locations in the mine and provide a constant check on its oxygen, methane, carbon monixide, and hydrogen sulfide content. Alarms will automatically sound if the threshold limits for such gases are reached, and immediate checks of the affected area will be made to determine the cause and to initiate control measures.

Escapeways and Refuge Chambers. The mine will have at least two separately maintained escapeways to the surface for underground personnel. Damage to one escapeway will not lessen the effectiveness of the other. The V/E and Service shafts, which are equipped with both hoisting facilities and emergency ladderways for personnel, normally will be used for such purposes. Designated escape routes to these shafts from the various working areas in the mine will be plainly identified. A diesel-powered mobile hoisting unit will be available for escape through other shafts

.3 Mine Safety

.2 Potential Safety and Health Hazards (Continued)

not equipped with hoisting and ladderway facilities. In the event of a hoisting failure, this unit also could be used in the shafts so equipped.

Refuge chambers equipped with life support systems will be provided for any isolated workings from which personnel access to the surface may be prevented by fire or other emergency. Such chambers also will be maintained on the level stations at the V/E and Production/Service shafts. All underground employees will be required to carry at all times the latest approved type of self rescuer that will provide up to one hour of personal protection from any carbon monoxide present in the mine atmosphere as a result of a fire. This period of protection is more than normally would be required to reach the surface or a refuge chamber.

Unexpected Hazards. Massive mine water inflows are not anticipated, but test holes will be drilled ahead of the initial development headings in each new mining area until it can be assumed that none will occur. The large areas opened up in the mine would serve as a reservoir to accommodate any such inflow until control measures were implemented or personnel were evacuated. Such test holes also would drain any methane gas that possibly could occur with the ground water or as isolated pockets in the strata.

3 Mine Safety

.2 Potential Safety and Health Hazards (Continued)

Rock mechanic considerations in the present mine design should prevent any massive pillar failures except in the case of the planned failure of the thinner pillars between the larger Phase III retorts. Such failure may result in minor surface subsidence. The large panel pillars around each Phase III mining panel should not fail.

The area around the Tract is one of very low seismic activity. Underground mining operations are routinely carried out in areas of much greater seismic activity without any appreciable effect. Other than the possible dislodging of loose rock from the back or ribs of the underground opeining, no serious mining or safety problems would be expected from a seismic event.

.4 Mine Fire Protection

The possiblity of accidental fire exists in many of the underground activities. However, reasonable mine design and proper operational safeguards will minimize both the protection for and the consequences of this hazard. A comprehensive plan will be developed to identify those sources having potential for causing accidental fires as well as the procedures for preventing and controlling them. Potential sources of underground fires will include fuels and lubricants, equipment, electric circuits, explosives, mine supplies, trash, and even the raw oil shale itself.

Mine Fire Protection

.1 Potential Fire Sources and Control Methods

Fuels and Lubricants. Diesel fuel, grease, and oil used underground have low volatility and high flash points, making accidental ignition unlikely. Underground storage of diesel fuel will be limited to those quantities consumed on a single operating shift. Storage and fueling operations will occur in specific areas near a return air course. Dry-break systems for fuel and lubricant transfer will minimize spillage. Should a fuel fire occur underground, it would be controlled with the dry chemical extinguishers mounted on all equipment or, if necessary, by a mine fire truck using high pressure foaming nozzles.

Equipment. Mobile diesel-powered equipment, conveyor belts, and the various electric-powered equipment throughout the mine also will be potential fire sources. Appropriate sensing and alarm systems and automatic dry chemical fire suppression systems, in addition to the portable dry chemical extinguishers carried on all mobile equipment, will be used for fire control.

Electric Circuits. The various electric circuits extending throughout the mine also will be a potential source of fire. Fire prevention measures will involve use of proper overload circuit breakers and the repair or replacement of damaged insulation.

4 Mine Fire Protection

.1 Potential Fire Sources and Control Methods (Continued)

Explosives. The potential for explosive fires, though remote, is a possibility inasmuch as the ANFO blasting agent used in mine development is flammable. As discussed before, this material would not be stored in the mine but would be supplied through boreholes from the surface as needed for immediate use. The small amounts of the material in transit from the loading point to the working area would be susceptable to ignition by carelessness or by fire in the transport vehicle. Proper procedures for such transport and frequent vehicle maintenance would minimize this hazard.

Supplies and Trash. Flammable mine supplies will include small amounts of lumber for concrete forms and bulkheads as well as the packing containers for parts and supplies. Storage, use, and disposal of these materials will be controlled. Trash from underground shops, warehouses, and lunchrooms will be disposed of in self-extinguishing containers provided for this purpose. Waste from such containers will be periodically collected and hoisted to the surface for disposal.

Oil Shale. Raw oil shale is a flammable material--the higher its grade, the easier its ignition. Small thin fragments of high grade shale can be ignited with a match to burn slowly with a smoky flame. Spontaneous combustion has occured in piles of

4 Mine Fire Protection

.1 Potential Fire Sources and Control Methods (Continued)

finely broken high grade shale, and the ignition of a broken shale muck pile by its blasting round has been reported. However, the permeability of the unbroken in-place oil shale is very low, and any fire involving such material would be confined to its exposed surface and would spread only laterally at a very slow rate. Owing to the slow burning characteristics of both the broken and in-place shale and the planned wetting of muck piles after blasting, the possibility of uncontrolled fires will be very remote. Piles of broken shale will not be allowed to accumulate in either the active or inactive workings.

.2 Fire Fighting Procedures

Any indications of a fire will be reported immediately via the central communications system to the fire control coordinator. No attempt will be made to control or extinguish any fire without first reporting the fire and seeking assistance. Upon receiving a report of a possible fire and its location, the fire control condinator will dispatch appropriate fire fighting equipment. Unless specifically determined to be unnecessary, he will activate the necessary audio, visual, and olfactory systems to initiate evacuation of all but emergency personnel along prescribed and posted escape routes.

.4 Mine Fire Protection

.2 Fire Fighting Procedures (Continued)

Emergency fire fighting equipment will be maintained at several of the shaft level stations and will be manned by specifically assigned and trained personnel. Fire trucks will be equipped to fight fires of all types and will be supported as necessary by the mine water trucks.

Preparedness training will be conducted regularly for all emergency crews. Instructions on fire control and evacuation procedures will be given all new employees. Self rescuers and instruction on evacuation procedures also will be provided for all visitors to the mine.

.3 Fire Monitoring and Control System

A computer supervised fire monitoring and control system will be installed as part of the overall fire protection system. It will supplement conventional fire protection practices.

Fire detectors will be strategically located throughout the mine. These will be installed near conveyor drives, pump installations, fuel and explosive storage facilities, and in the shaft level stations where numerous employees will be permanently assigned. Other areas will be evaluated, and detectors will be provided wherever regulations or safety considerations dictate.

4 Mine Fire Protection

.3 Fire Monitoring and Control System (Continued)

Fire doors for shutting off the normal air flow also will be installed throughout the mine. Detectors located in the areas between such doors will automatically actuate the appropriate doors to isolate any area in which combustion gases are detected. The mine ventilation system will permit such gases to be exhausted from any area so isolated without affecting other working areas.

In some areas, the sensing of combustion gases by a detector will automatically actuate local fire suppression systems. Such sensing by any detector will automatically trigger alarms in the affected area, the mine supprt computer center on the surface, and all fire control stations and safety offices.

SURFACE PROCESS FACILITIES

General

The surface process facilities (SPF) include shale oil/water separation and treatment, MIS offgas scrubbing and compression, MIS offgas combustion, steam generation and power production, flue gas desulfurization (FGD), water management, ammonia byproduct recovery, shale oil storage and shipping, and miscellaneous utilities. These facilities primarily process products generated from modified in situ (MIS) retorts. Some common facilties also serve the aboveground retorts (AGR).

The SPF's are depicted, along with the mine, MIS retorts, and AGR's, in the overall block diagram, drawing EF-200. The various sections are depicted in drawings EF-201 through EF-208, inclusive.

After raw MIS shale oil and retort water are separated in an underground sump, each is pumped to the surface. The raw shale oil is treated to separate any emulsion of water/oil and solids before going to tank storage. Before retort water is used for steam generation and utility water, residual oil, dissolved organic material, and sludge is removed. Oil/water separation and retort water treatment are closely integrated as a result of the presence of water in raw shale oil and oil in retort water.

The offgas scrubbing and compression section receives low-Btu MIS offgas, at approximately 65 Btu per cubic foot, subatmospheric pressure, and approximately 150°F from the gas shaft. This flow is split equally among four parallel and identical gas equipment

General (Continued)

trains, as further described in Section 5.2.2. A fifth train is provided as a spare.

Each train is sized to handle 25 percent of design flow. Each train consists of a combination precooler and ammonia scrubbing tower with auxiliaries, followed by blowers which deliver the gas at sufficient pressure and temperature (225°F) to special low-Btu burners in the modular steam boilers. The precooler in each train cools the gas, condenses light oils and water, and removes ammonia by direct contact with water.

The steam generation and power production facilities make the SPF and underground facilities self-sufficient in energy. Ten modular boilers produce 600 PSIG, 750°F steam in sufficient quantities to supply all steam needs and generate 13.8 kilovolt electricity in five noncondensing turbogenerators, of which three or four are normally operating. Sufficient electricity is generated to export a portion to the power grid for most of the year. Only during extremely cold weather is power imported. Five steam pressure levels will be available: 600 PSIG, 300 PSIG, 239 PSIG, 85 PSIG, and 20 PSIG. These are in addition to 412 PSIG steam available from the AGR's and fed directly to the MIS mine along with the 239 PSIG steam. Further discussion of steam generation and power production, including evaporation of dirty waters from water management facilities is given in Section 5.2.3.

SURFACE PROCESS FACILITIES

General (Continued)

The flue gas desulfurization section consists of five two-step contactors to remove sulfur dioxide from the flue gas by reacting it with a limestone slurry. The selected process, the Research-Cottrell Double Loop Limestone Process, has the advantages of high sulfur dioxide removal, high reagent utilization, and high reliability. The induced draft fan provided with each modular boiler is sized to generate sufficient pressure to accommodate the contactors. Reacted lime is mixed with AGR processed shale in the processed shale conditioning area for surface disposal. Details of the desulfurization facilities are given in Section 5.2.4. Processed shale conditioning is discussed in Section 6.6.

The water management section recycles and treats retort water from the MIS retorts and process water condensed from the MIS offgas so that the plant is self-sufficient in water and produces no contaminated effluent. Details of clean-up, ammonia removal, desalinization, treatment, collection, recycling, etc., are given in Section 5.2.5, which in turn gives detailed references to sections that describe handling of ammonia vapors and evaporation of dirty waters.

The byproduct recovery section using the US Steel Corporation's Phosam W Process produces high-quality fertilizer grade anhydrous ammonia for sale. Details are given in Section 5.2.6.

The product storage and shipping section includes tankage for about ten days storage of shale oil and ammonia, or 1,120,000 barrels and 2,850

General (Continued)

tons respectively. Shale oil will be transported via an oil shale pipeline provided by others. Ammonia will be trucked to a rail trans-shipment point in Rifle, Colorado. Section 5.2.7 gives details.

Utilities, including emergency power, auxiliary fuel, cooling water, compressed air, inert gas, and the flare system, are covered in Section 5.3.8.

MIS Oil Processing Facilities

.1 Shale Oil/Water Separation

The MIS retorts produce shale oil consisting of two fractions. The first fraction, which is a majority of the oil production, has an average water content of approximately 2.5 percent by volume. The second fraction is a stable emulsion (rag or cuff) and has an average water content of approximately 80 percent by volume. This rag or cuff emulsion fraction is preheated before being treated in the main shale oil/water separation process. The processing scheme is depicted in drawing EF-206.

The relatively small emulsion stream is heated in a heat exchanger and passes to the emulsion heater treater where bubbling and water washing, assisted by the coalescing action of baffle trays, breaks down most of the emulsion. The coalesced water and water wash settle to the bottom and are recycled to the water treating facilities. The recovered oil then joins the MIS raw shale oil stream for further processing. Sludge

MIS Oil Processing Facilities (Continued)

.1 Shale Oil/Water Separation (Continued)

goes to the treatment facilities shown on drawing EF-208.

Raw MIS shale oil, oil recovered from the emulsion heater treater, condensed light shale oil, and recovered oil from process water treating are combined and fed to two heat exchangers. Heating is done in two steps. The first raises the temperature to 196°F. As before, heat is supplied by exchange with the hot product oil coming from the electrostatic desalters. Secondly, hot clean steam condensate raises the oil temperature to 230°F.

The heated oil stream then passes to four parallel mechanical/thermal heater treaters. Similar to the emulsion stream, bubbling and water washing, assisted by the coalescing action of baffle trays, breaks most of the contained emulsion. The coalesced water and water wash settle to the bottom and are recycled to the water treating facilities. Sludges are sent to sludge treatment shown on drawing EF-208.

Effluent oil from the heater treaters flows to two electrostatic desalters. Clean water is introduced and gently mixed with the oil to reduce the salt concentration of the brine dispersed in the oil to form a new but less conductive water-in-oil emulsion. Subsequent passage through the high voltage electrical field

MIS Oil Processing Facilities (Continued)

.1 Shale Oil/Water Separation (Continued)

coalesces the water droplets into larger droplets which settle to the bottom. The collected water is recycled to the water treating facilities and sludges are sent to sludge treatment.

Finally, the oil is cooled in the preheat exchanger and piped to a 50,000 barrel tank for final settling of trace water and sludge. The resulting oil is expected to be 24 °API gravity, 1.5 weight percent nitrogen, 0.7 weight percent sulfur, 0.15 volume percent water, and 0.15 volume percent sludge. Expected viscosity is 70 SUS at 100°F and the untreated pour point is 25°F. From there, product shale oil is pumped to the storage facilities described in Section 5.2.7.

The MIS retorting schedule is shown in Table 5.1.

.2 Offgas Scrubbing and Compression

The offgas scrubbing and compression section of the SPF removes water vapor, light hydrocarbons, and ammonia from MIS offgas and boosts its pressure for delivery to the steam boiler burners. Offgas scrubbing and compression is the first section in each of the five parallel SPF gas trains. Four are normally operating, and one serves as a spare. Each train is, therefore, sized to handle 25 percent of the normal offgas flow of 3,024 million standard cubic feet of wet retort gas per stream day.

Table 5.1 MIS Retorting Schedule

e	Period (Quarter	Year)	Average Retorts (I	II)*	Underground Recovery (BPCD)	Surface Recovery (BPCD)**	Total MIS Oil (BPCD)
	1	1985	0	-	0	0	0
	2		0.3	-	155	16	171
	3		3	-	1,583	168	1,751
	4		5	-	2,751	291	3,042
	1	1986	8.5	-	4,457	472	4,929
	2		9	-	4,747	502	5,249
	3		16	-	8,156	863	9,019
	4		23	-	11,829	1,252	13,081
	1	1987	36	-	18,791	1,988	20,779
	2		43	-	22,578	2,389	24,967
	3		48	-	25,362	2,684	28,046
	4		55	-	28,802	3,048	31,850
	1	1988	64	-	33,393	3,533	36,926
	2		84	-	43,775	4,632	48,407
***	3		94	-	49,110	5,196	54,306
	4		96	-	49,900	5,280	55,180
	1	1989	91	6	49,556	5,244	54,800
	2		61	18	49,222	5,208	54,430
	3		31	30	48,878	5,172	54,050
	4		8	39	48,544	5,136	53,680
I	1	1990	-	42	48,200	5,100	53,300
	2		-	42	48,200	5,100	53,300
	3		-	42	48,200	5,100	53,300
	4		-	42	48,200	5,100	53,300

es:

Phase I retorts 165 x 165 x 290 ft.

Phase II retorts 165 x 380 x 290 ft

9.57% of total production

Full oil production

.2 Offgas Scrubbing and Compression (Continued)

Five train operation would give greater than 100 percent onstream factor and allow for a higher-than-design rate of oil production in the future. Four train operation would give an estimated onstream factor of about 93 percent.

The block flow diagram, drawing EF-201, depicts the offgas scrubbing and compression section.

Offgas is supplied to each train via a 16-foot-square duct from the gas shaft at 8.5 PSIA and 150°F. The gas contains about 30 volume percent water vapor. In each train, gas enters the bottom of the retort offgas precooler-ammonia scrubber, which is a five-bed, packed tower. In the tower, the gas is cooled to 85°F. A total of about 2800 GPM of water is condensed in four trains, and the ammonia content of the gas is reduced by nearly 90 percent. Some light shale oil is also condensed and recovered amounting to 5280 BPD for four trains. Cooled, scrubbed gas passes directly from the precooler-ammonia scrubber in each train to two parallel retort offgas blowers. A total of 10 blowers are supplied, eight operating and two spare.

Four stages of cooling are provided for the five stages of contact in each retort offgas precooler-ammonia scrubber, as shown in drawing EF-201. This drawing and the following paragraphs explain the complex tower piping arrangement.

MIS Oil Processing Facilities

.2 Offgas Scrubbing and Compression (Continued)

Because of the temperature drop in each stage, water condenses from the gas in each stage. Therefore, each stage produces excess water, which must eventually flow out of the tower. Stripped process condensate from the ammonia stripper is fed to the fifth (top) stage of the tower to provide the initial large flow to that stage, and condensed water supplements the flow in all five stages. With one exception, all flows of interstage water at the tower are via external piping, which is shown on the drawing at the right of the tower. The one exception is the internal water flow which passes from the second stage to the bottom of the tower through an internal sleeve. Excess water is removed from the tower at two points; namely the bottom of the tower and the bottom of the third stage. Excess water from the fifth and fourth stages pass, respectively, to the fourth and third stages. No water passes from the third to the second stage. All water from the second stage bypasses the first stage internally and passes to the bottom of the tower. The result is that the gas is cooled from 150°F to 85°F, and considerable water, ammonia, and light oil are condensed and recovered.

Most of the water condensed from the gas is condensed in the first two stages. Most of the ammonia is absorbed in the top three stages. For this reason, the first two stages represent

.2 Offgas Scrubbing and Compression (Continued)

the precooler, and the top three stages represent the ammonia absorber, hence the tower name: precooler-ammonia scrubber.

Oil is removed from the tower at the first, third, fourth, and fifth stages. Internal sumps, arranged to trap the less dense oily top layer, accomplish this inside each of the four designated stages. The oil flows to the light oil water separator, along with the small amount of oil from the oily water condenser. Here, any entrained water can be removed and recycled to the oily water coalescer.

The first precooler exchanger is a simple fin fan, or dry air cooler. The other three precooler exchangers are wet surface air coolers. In winter when air temperatures are low, these latter precooler exchangers can be operated without cooling water.

The tower is provided with an entrainment separator above the fifth stage. A sidestream of water for the fourth precooler is provided to clean the entrainment separator. At the bottom of the first stage and between stages, the tower is equipped with trays to catch the down flowing liquids and redistribute the up flowing gas. The bottom of the tower is sufficiently large to provide about 10 minutes of surge or settling time. The four oil effluent streams from the tower flow by gravity and are

MIS Oil Processing Facilities

.2 Offgas Scrubbing and Compression (Continued)

controlled by internal level sensors. Water streams leaving the tower are pumped out, and control valves are provided after each split. Water recycling to the tower via precooler exchangers is controlled by flow controllers located in the respective pipelines. Water flow from the tower first and third stages to the oily water coalescer is controlled by interface level controllers at their respective stages.

Sizing of the four precooler exchangers and determination of water rates is based on heat removal requirements with due consideration to (1) sensible heat content of gas due to its elevated temperature, (2) latent heats of condensation, and (3) heat of ammonia solution.

All of the water which leaves the tower and is not immediately recycled, along with a small amount of water recovered at the light oil water separator, flows to the oily water coalescer (one for each train) for removal of oil-rich emulsion. Water from the coalescer flows to the ammonia stripper for ammonia recovery. An interface level controller near the top of the oily water coalescer controls this water flow. Pressure of the effluent oil controls oil flow. The oil passes to the light-oil water separator.

MIS Oil Processing Facilities

.2 Offgas Scrubbing and Compression (Continued)

Oil from the tower, along with a small amount of oil emulsion from the oily water coalescer, passes to the light oil/water separator. The separator is the tilted plate type, and is heated by a steam coil, with the steam flow controlled by a temperature controller regulated by separator temperature. Oil is collected at the top of the separator and is pumped to the oil separation area. Water is taken off the bottom and is pumped to the oily water coalescer. Provision is made at the bottom of the separator for sludge removal and transfer to the sludge thickener.

The cooled, scrubbed MIS offgas leaving the top of the precooler-ammonia scrubber amounts to about 2.3 billion standard cubic feet per day, or 76 percent of the entering volume due to removal of most of the water, ammonia, and light oil. The gas then passes via 14 by 10-ft square ducts to the retort offgas blowers. Two blowers are provided in each train, running in parallel. Each blower is designed to handle a normal flow of 451,000 actual cubic feet per minute. Manifolding and valving is provided to enable one blower to be removed from service for maintenance with the respective train running at design capacity by use of a spare blower. Instrumentation is provided to control the blower discharge pressure at a constant 1.0 PSIG (12.4 PSIG) to send a steady flow of fuel to the 600

MIS Oil Processing Facilities

.2 Offgas Scrubbing and Compression (Continued)

PSIG steam boiler burners. This is equivalent to a blower differential of 6.1 PSI. A bypass duct is provided for startup and shutdown. Blower drivers are 600-PSIG steam turbines, which exhaust to air-cooled surface condensers. The clean condensate is returned to the boiler feed water deaerator.

General Support Facilities

.1 Steam Generation and Power Production

This section includes the steam plant and the main step-up, step-down transformer yard and power substation. It does not include the 412 PSIG steam generators in the surface retorting section.

The steam plant consists of 10 modular boilers, five turbo-generators, 48 kettle evaporators, and auxiliaries.

Five pressure levels of steam are produced: 600 PSIG, 300 PSIG, 239 PSIG, 85 PSIG, and 20 PSIG. Electricity at 13.8 kilovolts is generated and fed to the main substation.

Drawing EF-202 is a block flow diagram showing the five steam headers and the relationship between sources and users.

The modular boilers are arranged in five pairs, with four pairs normally operating and one pair serving as a spare. Each pair of boilers share one stack. Each boiler has its own steam

.1 Steam Generation and Power Production (Continued)

drums, forced draft fan, induced draft fan, and (via a common header) flue gas desulfurizer with auxiliaries. The boilers are fired with MIS offgas and AGR offgas, as noted on the drawing. The flue gas desulfurization equipment is described in Section 5.3.2.

Each boiler is rated at 653,000 pounds per hour of 600 PSIG, 750°F superheated steam. Normally, eight operating boilers will supply 5.2 million pounds per hour of superheated steam to the 600 PSIG steam header.

The 300 PSIG saturated steam is produced by desuperheating the exhaust steam from the facility's turbine drivers, which are powered by 600 PSIG steam. The 300 PSIG steam is used mainly for heating the steam generators in process service, for desulfurizer stack gas reheating and plume rise after scrubbing, for water management services, and for supplementing the 85 PSIG steam by pressure letdown and desuperheating. Process steam is generated from oil contaminated water. It is isolated from the clean steam system.

The 239 PSIG saturated steam is produced in 36 double-ended U-tube kettles. Feed water is oil contacted process condensate and stripped retort water. This "process" steam amounts to 1.16 million pounds per hour, and is used as steam for MIS retorting.

General Support Facilities

.1 Steam Generation and Power Production (Continued)

The pressure was selected as a reasonable minimum to meet steam pressure requirements at the steam utility bore hole. The 36 kettles are double-ended TEMA AKU type and are heated with 300 PSIG steam. Each of 10 kettles evaporates 29,000 pounds per hour stripped retort water, and each of the remaining 26 kettles evaporates 34,000 pounds per hour of ammonia stripper process condensate. Use of these process waters for steam production serves to close the process water and steam loops. The 239 PSIG steam to the mine is supplemented with 412 PSIG steam from the surface retorting facility. The 85 PSIG steam is supplied mainly from five turbogenerators. For balancing and make-up, a small amount is also supplied from letdown and desuperheating of 300 PSIG steam, from water management turbine drivers, and from blowdown of the modular boilers. About 1.3 million pounds per hour of 85 PSIG steam is extracted from the turbogenerators, which are described at the end of this section. The 85 PSIG steam is used to produce 20 PSIG steam in the excess water evaporator, for water management purposes, and for miscellaneous heating and steam tracing.

The 20 PSIG steam is produced in 12 double-ended U-tube kettles from various boiler blowdown streams and miscellaneous water streams from water management. Approximately 0.45 million

General Support Facilities

.1 Steam Generation and Power Production (Continued)

pounds per hour are produced, and of this about 0.15 million pounds per hour are vented to the air. The remainder, supplemented with blowdown from the modular boilers, is condensed and supplies water for cooling tower make-up, for utility water, and for the wet air coolers via the utility water reservoir tank. The 12 kettles are double-ended TEMA AKU type and, as already indicated, heated with 85 PSIG steam.

The turbogenerators are single stage automatic extraction type, each rated at 33.5 megawatts. Normally, four are operating and use all excess 600 PSIG steam not required by the mine, MIS retorts, and surface processing facilities. One is a spare. In summer, the turbogenerators use about 2.1 million pounds per hour of 600 PSIG steam and extract about 1.3 million pounds per hour of 85 PSIG steam for plant use. The remainder is taken to air-cooled surface condensers operating at a pressure of 4.5 inches of mercury. Up to 167 megawatts of electricity at 13.8 kilovolts is sent to the step-up, step-down substation facility in summer. Because of an additional steam requirement of 0.40 million pounds per hour for the mine and MIS retorts in winter, generation can fall as low as 108 megawatts. This means that in summer 18.0 megawatts at 13.8 kilovolts can be exported to the Meeker power grid, but on the coldest winter days, 7.4 megawatts must be imported from the grid. The overall concept

General Support Facilities

.1 Steam Generation and Power Production (Continued)

is to attain power self-sufficiency for the plant whenever possible. This concept is extended to the use of 600 PSIG steam turbines for the larger drivers and certain other drivers to improve reliability and minimize significant transients to the Meeker grid.

.2 Flue Gas Desulfurization

Before discharge to the atmosphere, the 600 PSIG steam boiler flue gas is contacted with two stage limestone slurries in a spray-type absorber tower. Two stages are employed to accomplish maximum removal of sulfur dioxide while obtaining efficient utilization of reagent. The desulfurization scheme is summarized in the block flow diagram in drawing EF-203.

The desulfurization process is the Research-Cottrell Double-Loop Limestone Process. Sulfur dioxide removal rates of 95 percent are expected, and essentially complete reaction of the limestone is anticipated. Reliability is high, particularly in view of having a fifth stand by system and a common header arrangement.

The chemistry and physics of the process are summarized in three steps: (1) absorption of sulfur oxides into the liquids; (2) reaction with the limestone and precipitation; and (3) oxidation of sulfite to sulfate.

General Support Facilities

.2 Flue Gas Desulfurization (Continued)

Ten towers are provided, two with each system. Each of the five systems include one absorber tank, one quencher/absorber tank, and one reagent feed tank. Each system also includes two reagent feed pumps, four quencher pumps, four spray pumps, and six packing pumps. Also provided for the five systems are a limestone storage shed, ball mill, vacuum filter, and conveyor belt.

In the tower, the sulfur dioxide reacts with finely divided limestone to form calcium salts which are not volatile and, hence, remain in the aqueous slurry for eventual disposal with AGR processed shale. Sufficient pressure to force the flue gas through both stages of the desulfurization absorber is developed by the induced draft fan provided with each modular boiler.

Flue gas enters the bottom of the tower and flows upward through the lower loop, then around the collection pan in the tower, and finally through the wetted film contactor and demisters in the upper section. The two loops in each tower operate at slightly different chemical conditions. The upper loop, also known as the absorber loop, is maintained at a pH of about 6.0 by varying the flow and solids composition of the limestone slurry fed to the top of the absorber tower. High pH favors efficient removal of sulfur dioxide. The

.2 Flue Gas Desulfurization (Continued)

slurry is continuausly recycled through the upper absorber loop, with a bleed stream from the absorber tank to the lower loop. The lower loop, also called the "quencher loop," is maintained at a pH of about 4.5 by controlling the flow of make-up slurry from the absorber tank. This favors complete reaction of the limestone. The lower quencher loop receives fresh make-up water to replace that evaporated due to high flue gas temperature, as well as partially reacted limestone slurry from the upper absorber loop. Waste brines from other sections of the surface process facilities are disposed of by mixing them with slurry at the lower loop. Waste slurry containing 15 percent solids is removed on level control from the quencher/absorber tank and is sent to the dewatering section. Oxygen contained in the flue gas partially oxidizes the calcium sulfite to calcium sulfate. Lower pH favors oxidation, as exists in the lower loop of the tower. The tower also includes provision for air injection into the bottom to increase the formation of calcium sulfate or gypsum to nearly 100 percent. Oxidation to the sulfate form improves settling time, filterability, and landfill properties, particularly by reducing or eliminating leaching, instability, and thixotropic behavior.

General Support Facilities

.2 Flue Gas Desulfurization (Continued)

The waste slurry is dewatered by cyclone and vacuum filters to provide a filter cake with only 20 percent water. The filter cake is then mixed with spent shale from the AGR units in the processed shale conditioning section for landfill disposal, as discussed in Section 6.6.

Trucks deliver limestone to conveyors at the storage shed. The limestone is subsequently weighed and pulverized in ball mills to minus 200 mesh. Water is fed to the ball mills to give a pumpable slurry which is stored at 30 to 40 percent solids in the reagent feed tank. The slurry is then pumped to the absorber tank, where it is diluted with water and maintained at 10 percent solids.

After the scrubbed flue gas leaves the absorber, it is reheated with 300 PSIG steam and discharged to atmosphere through one of five stacks, each 30 feet diameter and 300 feet tall. FGD performance and materials are shown in Table 5.2.

.3 Water Management

Mine water is available from the mine at approximately 450 gallons per minute. Water quality is shown in Table 5.3. This water is pumped from the mine sump to the surface facilities for treatment, which includes clarification, filtration, and desalinization by reverse osmosis. The treated water contains less than

Table 5.2 Flue Gas Desulfurization

	Common Units	TPCD
INPUT		
Flue Gas, Dry*	4145 MSCFD**	162150
(SO_2 content)	1000 ppm V	(350)
Limestone	-	518
Water		409
TOTAL		163077
OUTPUT		
Desulfurized Gas, Dry*	4141 MSCFD**	161963
(SO_2 content)***	50 ppm V	(17.5)
Gypsum $CaSO_4 \cdot 2H_2O$		891
Free Water	20% slurry	223
TOTAL		163077

Notes:

* Water entering and reheat steam omitted from balance

** M = million

*** Particulate emissions negligible for absorber type unit.

Table 5.3 Mine Water Quality

Substance	Concentration (mg/l)
Ca^{+2}	34
Mg^{+2}	43
Na^{+}	269
HCO_3^{-}	644
CO_3^{-2}	15
Cl-	23
SO_4^{-2}	233
SiO_2	17
TDS*	1285
pH	8.5
Suspended Solids	Variable**

tes:

TDS = Total Dissolved Solids

Higher during initial mine devleopment phase than during later mining activities.

100 PPM of total dissolved solids and is suitable for clean water uses. The processing scheme is shown in block flow diagram EF-207.

The mine water is first pumped to a clarifier where free oils are skimmed off and solids are settled out as sludge. The recovered oil is pumped to the raw shale oil separation system. The clarified mine water is then pumped to a filter that has been precoated with diatomaceous earth to remove suspended solids.

The precoat filter is supplemented with a mixing tank, agitator, precoat pump, feed pump, and backwash sludge removal system. During operation, when the pressure drop across the filter rises to a predetermined value, the filter is automatically backwashed with filtrate. The solids-laden backwash is pumped to the sludge dewatering area.

The filtered water is pumped from the precoat filter through a heat exchanger to the reverse osmosis (RO) unit. The exchanger warms the water stream from 60°F to 80°F with heat from hot condensate to increase membrane efficiency and minimize scaling. A small feed of sulfuric acid and sodium hexametaphosphate are added to the water stream before it reaches the RO unit to reduce scaling from calcium carbonate and calcium sulfate. The

5.3 General Support Facilities

.3 Water Management (Continued)

acid injection rate is controlled to give a pH of 6.0 in the water stream entering the RO unit. If the fluoride concentration proves to be high, an additional stream of soluble silica must be added to prevent scaling with calcium fluoride, because water used for drinking must have a fluoride content less than 1.0 PPM. A second method to reduce calcium formation is the addition of sodium zeolite upstream of the RO unit.

The RO unit incorporates five parallel banks, each having 29 permeators in two stages. The unit requires an inlet pressure of 400 PSIG and gives an overall recovery of 80 percent. The total dissolved solids (TDS) concentration is reduced from the 1200 PPM level to about 74 PPM. The effluent brine from the unit has a total dissolved solids concentration of about 6000 PPM, and is sent to the high TDS header for further concentration in the excess water evaporators. The desalinated water is initially stored and then pumped to users such as the Research-Cottrell flue gas desulfurization unit, boiler feed water treaters and potable water system.

The potable water requirement for the entire mine, MIS retorts, and surface facilities is about 170 GPM. The desalinated water from the RO unit must be further filtered and chlorinated to produce potable water. The filter will incorporate a

.3 Water Management (Continued)

carbon bed, alumina bed, or molecular sieves. A pressure surge tank will deliver the water on demand.

Boiler feedwater is required by the modular boilers and the surface retorting units. The boiler feedwater will be produced from desalinated water from the RO unit by running it through a sodium zeolite treating system. The calcium and magnesium ion concentration is reduced to about 3 PPM, a level safely below the 5 PPM maximum allowed for the modular steam boilers. Regeneration of the zeolite treater is accomplished by back-washing with aqueous sodium chloride. The backwash is disposed via the high TDS header. The process condensate stream is produced at the rate of about 2800 GPM. This is the water condensed from the MIS offgas during precooling upstream of the blowers, as described in Section 5.2.2. This water is relatively corrosive due to the presence of dissolved ammonia, hydrogen sulfide, carbon dioxide, volatile organics, and small amounts of minerals. Suspended condensable shale oils and some traces of heavy shale oil are also present.

The ammonia-rich condensate from the oily water coalescer and the Lurgi-Ruhrgas process gas liquor are steam stripped in a stripper equipped with stainless steel valve trays to recover ammonia, to remove the corrosive dissolved gases, and to remove

.0 SURFACE PROCESS FACILITIES

.3 General Support Facilities

.3 Water Management (Continued)

volatile organics such as soluble light oils. Any heavier shale oil layer which collects at the tower bottom or in the partial condenser reflux drum is recovered and sent to the oil separation system. The stripper overhead vapors, which include ammonia, hydrogen sulfide, carbon dioxide, traces of oxygen, volatile organics, and steam vapor, are sent to the Phosam units. See drawing EF-204 for a block flow diagram.

The stripped process condensate is sent to the 239 PSIG process condensate steam generators where continuous and high-rate intermittent kettle blowdown systems are used to control TDS and remove any buildup of suspended material and oils.

Before entering the ammonia strippers, the ammonia-rich process condensate is preheated by exchange with hot stripper bottoms in an external heat exchanger. The overhead vapors from all the ammonia strippers contain about 23,800 pounds of ammonia per hour. The stripped bottoms stream is split in half. One half goes to the process condensate steam generators as described in Section 5.3.1. The second half is cooled to 95°F and sent to the top of the retort offgas precooler-ammonia scrubber as described in Section 5.2.2.

Ammonia-rich vapors from the ammonia strippers pass to the Phosam unit as described in Section 5.3.4 and shown schematically

5.0 SURFACE PROCESS FACILITIES

5.3 General Support Facilities

.3 Water Management (Continued)

with the ammonia strippers on drawing EF-204. Water leaving the Phosam unit is returned to the ammonia stripper.

Retort water is separated from emulsified raw shale oil in an underground sump and continuously pumped to the surface facilities. This water is further treated to remove the remaining oil and sludge. The water is then steam stripped and vaporized to make dirty process steam. Process steam is used in the MIS retorts.

Retort water treating includes primary coarse filtration, tilted plate oil separation, final bed filtration, mechanical coalescing, and steam stripping, as shown in drawing EF-205. The system represents a single processing train with multiples of equipment provided for all essential functions to provide reliability to the system. There are, for example, two 75-percent-capacity steam strippers, three separators, two coalescers, and parallel heat exchangers equipped with bypasses. Two off-line storage tanks provide short-term storage of excess retort process water.

The retort water stream amounts to 1694 GPM and contains traces of oil and sludge along with some dissolved gases, such as ammonia, hydrogen sulfide, carbon dioxide, oxides of sulfur, as well as dissolved inorganic salts and soluble

.3 Water Management (Continued)

organic species. Inorganic salts are expected to be about 1.3 percent by weight. The retort water received from the MIS operations is pumped through three parallel mixed media gravel beds to remove large suspended solids and some emulsion. A fourth bed is provided as a spare. Whenever the pressure drop across the bed rises to a preselected level, that bed is automatically backwashed with filtrate from the other beds. The backwash passes to a clarifier equipped with an oil skimmer, sludge rake, and steam coil. The clarified water is pumped back to the process water stream. The skimmed oil is pumped to shale oil/water separation, and the wet sludge is sent to sludge dewatering.

The primary filtrate is combined with the water recovered from the oily water sewer system and is sent to the tilted plate oil separators to remove the oil. The oil removed in the separator is pumped to shale oil/water separation, and the water is pumped through a heat exchanger to secondary filtration. In the exchanger, the temperature of the water stream is increased from about 150°F to 180°F by exchange with hot clean condensate. This facilitates the breaking of the emulsion and improves the operation of the downstream coalescer. The preheated stream passes through parallel beds of sand filters to remove fines. Six

5.3 General Support Facilities

.3 Water Management (Continued)

are provided. The secondary sand filters are backwashed in a similar manner to the primary filters. The backwash is collected in the clarifier for oil skimming and sludge concentration.

Coalescers remove additional oil and sludge from the water stream. The secondary filtrate is combined with retort water recovered from the shale oil/water separation and passes through two parallel wafer-pack coalescers. The separated oil is pumped back to the shale oil/water separation area, and the water continues to two parallel steam strippers. Before entering the steam strippers, the retort process water is preheated to about 210°F by exchange with hot stripper bottoms. The stripper removes ammonia plus small amounts of hydrogen sulfide, carbon dioxide, sulfur compounds, and volatile organics. The stripper overhead vapors are sent to the ammonia absorber in the Phosam unit as described in Section 5.3.4. The steam stripper bottoms stream is sent to the dirty steam generators and to the excess water evaporators.

The raw shale oil stream received from the mine contains about 2.5 volume percent water. Water is removed from this oil similar to the process water treating just described. Shale oil processing is covered in Section 5.2.1.

5.0 SURFACE PROCESS FACILITIES

5.3 General Support Facilities

.3 Water Management (Continued)

The excess water disposal system provides a means to rid the various water streams of solids. The various blowdown streams which have high concentrations of TDS are combined with the stripped retort water from the steam stripper bottoms and sent to the excess water evaporators. From the excess water evaporators, a portion of the brines or solids-laden water is sent to the Research-Cottrell flue gas desulfurization unit, where the solids are disposed with FGD sludge.

Clean utility water is produced by condensing some of the 20 PSIG steam in air coolers. Some steam is vented directly to the incinerator stack as described in section 5.3.1.

The various dilute sludges are collected in the sludge dewatering area for treatment and disposal. The relatively dilute combination is pumped to a thickener where 24-hour residence time is sufficient to allow solids and heavy materials to settle to the bottom. The supernatent water is returned to the retort water treating area. The concentrated sludge is pumped to a mixing tank where it is mixed with lime and the sludge-lime mixture flows to a rotary vacuum filter for dewatering. The recovered water is combined with the water from the thickener and returned to the retort water treating system. The moist, solid cake is removed from the vacuum filter

.0 SURFACE PROCESS FACILITIES

.3 <u>General Support Facilities</u>

.3 <u>Water Management</u> (Continued)

and sent to an incinerator via a screw conveyor. The incinerator is sized to handle solids from sludge dewatering and from the sanitary sewer system, as well as combustible plant trash. Ash is disposed of by mixing with surface retort processed shale and FGD sludge in the processed shale conditioning section for surface landfill disposal.

The SPF's utilize two systems of wastewater collection and disposal. These are the oily water sewer system and the sanitary sewer system.

Oily water drainage is pumped from the oily water sewer system by lift pumps and sent to a clarifier which separates the oil, water, and sludge. Contaminated storm water is accumulated in a catchment basin sized for a 100 year storm flow. Lift pumps transfer this water to the clarifier. To allow time for separation, the oily water is held in the clarifier for about 24 hours. The water is then pumped to the retort water treating system, the oil is pumped to the shale oil/water separation system, and the sludge is pumped to sludge dewatering. The clarifier also serves as a surge basin for storm water treating.

The sanitary sewer system collects all sanitary wastes. Lift pumps send the water to the sanitary sewer treating plant, which is a multi-function circular waste treatment unit employing

5.0 SURFACE PROCESS FACILITIES

5.3 General Support Facilities

.3 Water Management (Continued)

an extended aeration process. Raw sewage enters the plant through a comminutor (bypass bar screen) and passes through an aeration tank to the clarifier zone, where it is maintained in a quiescent condition to allow aerated solids to settle to the bottom for collection. Effluent from the clarifier is pumped through a filter to a contact tank, where chlorine is introduced. The treated water is then discharged from the sewage plant to the land sprinklers. Alternate winter discharge is to processed shale conditioning.

Solids accumulating in the clarifier bottom are constantly cycled to the aeration tank. The returning sludge undergoes further digestion in the aeration tank and provides organisms for starting digestion of the incoming raw sewage. Excess sludge is diverted to an aerated sludge holding tank to maintain optimum plant efficiency. A skimming device is provided on the surface of the digester-thickener to remove floating scum which is returned to the aeration tank. Sludge from the bottom of the digester-thickener is routed to the incinerator for disposal.

.4 Byproduct Recovery

Ammonia is the only usable or marketable byproduct. Sulfur is not produced as a byproduct, but is recovered from the retort gas combustion products in the form of calcium sulfate. This material is mixed with spent shale for surface landfill disposal.

.0 SURFACE PROCESS FACILITIES

.3 General Support Facilities

.4 Byproduct Recovery (Continued)

High-quality fertilizer-grade anhydrous ammonia is produced in US Steel Corporation's Phosam W Process by recovering ammonia from ammonia-laden process vapors.

The Phosam process recovers ammonia from the overhead vapor streams, specifically those from the ammonia strippers and from the steam strippers. Both sets of strippers are described in Section 5.2.3. The water condensed from the vapors are returned from the Phosam process to the ammonia strippers. The ammonia-free vapors from the Phosam process are passed to the modular boilers for incineration.

Two Phosam units are provided, each designed to handle 75 percent of the plant total. When maintenance or unforeseen emergency requires one system to be down, the remaining system will operate at 100 percent of plant capacity for short periods by directly sending some sour steam vapors to the modular boilers. However, the sour gas SO_2 combustion products are recovered in the flue gas desulfurization unit. In addition, a process condensate storage tank with a capacity of 7 million gallons, amounting to about 24 hours storage, is provided upstream of the ammonia stripper.

The Phosam process was chosen because of its proven reliability on similar vapors, such as coke-oven gas, which also contains

5.3 General Support Facilities

.4 Byproduct Recovery (Continued)

substantial amounts of hydrogen sulfide and volatile organics. In the Phosam process, the incoming vapors are fed into the bottom of an absorber where ammonia is removed by counter-current contact with a phosphoric acid solution. After ammonia removal and moisture reduction, the sour tailgas from the top of the absorber is burned in the modular boilers as shown on drawing EF-202. The bottoms stream from that absorber is pumped through a feed effluent exchanger and into a stripper-regenerator. In the stripper-regenerator, the ammonia is driven off as a vapor and the lean phosphoric acid solution is recycled to the absorber. The ammonia vapor is liquified in the feed-effluent exchanger and fed into a high-pressure distillation column. The aqueous bottoms stream, which contains very little ammonia, is recycled back to the ammonia stripper to combine with the process condensate. The overhead vapors are liquified in a condenser. This liquid is high-quality fertilizer grade anhydrous ammonia. The ammonia production rate of 285 tons per day is transferred to the product storage and shipping area.

.5 Product Storage and Shipping

Storage tanks are provided for ammonia and product shale oil. Ten days capacity is the criterion for both sets of tanks. Ten horizontal, cylindrical steel tanks, each 14

.3 General Support Facilities

.5 Product Storage and Shipping (Continued)

feet in diameter and 96 feet long, are provided for 2850 tons of ammonia storage. Tank trucks ship 285 TPD of anhydrous ammonia from the C-b Tract to Rifle, Colorado, for shipment via railroad tank cars.

Seven vertical steel tanks, each with a capacity of 160,000 barrels, are provided to store 1.12 million barrels of product shale oil.

Plans for shipping shale oil will be completed when details of the product pipeline are available. Preliminary designs indicate that shale oil shipments will occur every two to three days. Transfer pumps with a capacity of 10,000 to 12,000 barrels per hour will be provided in the storage area. High initial oil production rates of MIS and AGR require the pipeline be installed within one year of starting tract oil production, since 10,000 barrels per day would require 84 daily truck shipments during the second quarter of 1986.

.6 Utilities

This section covers emergency power, auxiliary fuel, cooling water, compressed air, inert gas, and the flare system. Steam generation is covered in Section 5.3.1. Water treatment and handling is covered in Section 5.3.3.

.0 SURFACE PROCESS FACILITIES

.3 General Support Facilities

.6 Utilities (Continued)

The emergency power generation package is sized for operation of two boiler trains. The rating is 14,000 KW. This is sufficient to run four forced draft fans, four induced draft fans, three boiler feedwater pumps, and minor auxiliaries. Shale oil supplied from a nearby day tank provides auxiliary fuel for the boilers. Diesel fuel is an option.

The cooling tower is capable of supplying 25,000 GPM of cooling water. This rate is sufficient to supply all surface facilities, including AGR units. The tower is designed for 27°F cooling to 68°F using a 6°F approach to the summer design wet bulb temperature.

In addition, a closed loop cooling water system is provided to supply 500 GPM cooling water for jacket cooling of equipment. It provides 81°F water at about 70 PSIG. The system includes a surge tank, a heat exchanger, and a water pump.

Compressed air for plant and instrument use is provided by a package system designed to supply 4000 SCFM of -50°F dew point air at 100 PSIG. The package includes a backup compressor designed to automatically start upon failure of the operating compressor.

Two inert gas generators are designed to supply 500 SCFM of inert gas with a -50°F dewpoint at 40 PSIG. Each package unit

.0 SURFACE PROCESS FACILITIES

.3 General Support Facilities

.6 Utilities (Continued)

includes a compressor, a drying tower with automatic regeneration, a cooler, a surge drum, and analyzers for oxygen and moisture.

Two flare systems are provided for emergency use only. The flare for MIS retort offgas consists of a 30-foot-diameter, 200-foot-high concrete stack equipped with igniters sized to handle the total MIS retort offgas flow of 3 billion SCFD. The flare for surface facilities (pressure reliefs and Lurgi units) consists of a 20-inch-diameter, 200-foot-high carbon steel stack equipped with igniters sized to handle 10 million SCFD.

.0 SURFACE RETORTING

.1 General

This section describes the methods of handling, crushing and retorting the raw shale hoisted to the surface during mine development. Eight Lurgi Ruhrgas (LR) Process modules will be installed sequentially between 1985 and 1990 to achieve full surface retorting production. On the average seven units operate while one is out of commision for service and maintenance; however, all systems are designed to accomodate 8 module operation.

From 1982, when mining commences, until July 1985, when the first surface retorting module is operating, all raw shale will be stockpiled for future retorting. Section 7.1 discusses this operation in detail. The remaining seven modules become operational in approximately six month intervals beginning July 1987 and ending July 1990.

The average feed capacity of eight surface modules exceeds the average mine production. The balance of the feed requirements is made up from previously stockpiled raw shale. Table 6.1 shows the expected raw shale production, surface processing requirements, and stockpile rates from initial surface module operation in July 1985 through eight-module operation in 1990.

Rates are shown for both an operating day, which is also called a stream day (SD), and calendar day (CD) which is the annual average rate. Stream day rates multiplied by the expected availability factors yield calendar day rates. Availability factor is the number of operating days per year divided by 365. Note, only calendar day rates are additive for systems with different availability factors.

Phase	Retort Module No.	Fraction[6]	Period	Shale Production[1,3] TPSD	Shale Production[1,3] TPCD	Raw Shale To Stockpile[1,3] TPSD	Raw Shale To Stockpile[1,3] TPCD	Shale Crushing And Screening[2,3] TPSD	Shale Crushing And Screening[2,3] TPCD	Retorting Oil Production[2] BPSD	Retorting Oil Production[2] BPCD
I	1	0.5	July 1985 - July 1986	27,945	26,830	23,918	22,971	4,410	3,859	2,760	2,415[4]
I	1	0.75	July 1986 - July 1987	40,690	39,060	34,657	33,271	6,615	5,789	4,140	3,620[4]
I	2	1.5	July 1987 - Jan. 1988	57,500	55,200	46,026	44,185	13,230	11,575	8,280	7,245[4]
I	3	2.0	Jan. 1988 - July 1988	59,000	56,640	42,922	41,205	17,640	15,435	11,040	9,660[4]
I	4	3.0	July 1988 - Jan. 1989	59,000	56,640	34,882	33,487	26,460	23,153	16,560	14,490[4]
I	5	4.25	Jan. 1989 - July 1989	59,000	56,640	24,833	23,840	46,855	32,800	23,460	20,530[4]
I	6	5.675	July 1989 - Jan. 1990	59,000	56,640	13,378	12,843	50,055	43,797	31,325	27,410[4]
II	7	6.675	Jan. 1990 - July 1990	55,900	53,664	2,238	2,149	58,875	51,515	46,060	40,300[5]
II	8	7.675	July 1990 - Jan. 1991	55,900	53,664	-5,800	-5,568	67,695	59,232	52,960	46,340[5]
II	8	8.0	Jan. 1991 -	55,900	53,664	-8,412	-8,076	70,560	61,740	55,200	48,300[5]

Notes:
1. Mining Availability Factor 0.960 (350 days/yr)
2. LR-Retorting Availability Factor 0.875 (319 days/yr)
3. Only calendar day rates are additive for different stream factors
4. Based on 24 GPT average assay
5. Based on 30 GPT average assay
6. Initial capacity of retort module reduced at startup

SURFACE RETORTING

Raw Shale Handling and Storage

Raw oil shale will be hoisted to the surface and dumped into the raw shale receiving hopper located in the production shaft headframe. Apron feeders will withdraw the raw shale from the receiving hoppers, discharging onto covered belt conveyors for transportation to the truck loadout bin and the raw shale stockpile. The raw shale disposal stockpile will be used for future surface retorting. A conveyor transfer system will be incorporated at the truck loadout bin to supply feed material to the surface facility as the retorting modules begin operations. Drawing EF-220 is a block flow diagram showing the process of raw shale handling prior to surface retorting.

During surface retorting, the raw oil shale will be discharged from the coarse ore conveyors into 12-ft diameter by 85-ft-high concrete stacking towers. The material will flow out of the towers through doors located around the circumference from the bottom to top forming a 50,000 ton capacity conical pile around each tower. Each pile will contain approximately 13,000 tons live storage and 37,000 tons of dead storage.

The hoisting and stockpiling operations will operate on a three-shifts-per-day, 5.5 hours-per-shift schedule. This schedule will be followed for 20 shifts per week with one shift per week set aside for equipment maintenance.

The raw oil shale will be reclaimed from the conical stockpiles and continue through secondary and tertiary crushing systems.

0 SURFACE RETORTING

2 Raw Shale Handling and Storage

Crushing will reduce the material from -8 inches as received from the mine to the 1/4 inch size required by the retorting plant. All material minus 1/4 inch is suitable feed stock for the Lurgi Ruhrgas Process.

The -8 inch coarse ore will be reclaimed from the stockpiles by four apron feeders arranged in "H" patterns in reclaim tunnels under each stacking tower. The apron feeders will discharge onto the coarse ore reclaim belt conveyors for transport to the crushing area.

During periods when the hoisting and stockpiling systems are not in operation, the dead storage material will be pushed into the reclaim feeder openings by mobile equipment.

Fugitive dust that is generated during conveying, stockpiling and reclaiming will be controlled by covered conveyors, baghouse dust collectors and water-surfactant dust suppression systems. These are further discussed in Section 6.8, Emissions.

3 Crushing and Screening

The -8 inch raw oil shale will be delivered to the secondary crushing area on a three shift-per-day, seven day-per-week schedule at the stream day rates shown in Table 6.1.

The material discharged from the reclaim conveyors will be discharged onto double deck scalping screens for sizing ahead of the

Crushing and Screening

secondary crushers. The size separation will be 2 inches on the upper deck and 1/4 inch on the lower deck of the scalping screens.

The -1/4 inch material passing through the lower decks of the scalping screens will go directly to the 30,000-ton retort feed storage silo via fines collecting conveyors. The material sized between 1/4 inch and -2 inches which passes through the upper deck of the scalping screens, discharges from the screens onto a system of belt conveyors for transport to the tertiary crushing area. The remaining 2 inch by -8 inch size material discharges from the upper deck of the scalping screens into the secondary crushers which are in series with the screens. The secondary crushers will reduce the size of the material to -2 inches.

The secondary crushers discharge onto the secondary crusher product screens which are in series with the crushers. Size separation on the screens is 1/4 inch. The screen undersize, -1/4 inch material, is discharged onto the fines collecting conveyors and transported to the retort feed storage silo. The 1/4 inch screen oversize material is conveyed to the tertiary crushing surge hopper along with the 1/4 inch by -2 inch material discharged from the double deck scalping screens.

All the 1/4 inch by -2 inch size material from the coarse ore scalping screens, secondary product screens and recycle tertiary crusher product screens are collected and transported to a tertiary

surge hopper via a series of recycle belt conveyors. To provide for sufficient height above the surge hoppers and a change in the direction of flow of the recycle material, a transfer tower is incorporated into the facility. A conveyor belt tripper will distribute the tertiary crusher feed material over the length of the surge hopper above the crushers.

Belt feeders withdraw the 1/4 inch by -2 inch material from the surge hopper. The belt feeders discharge into the tertiary crushers which reduce the size of the material to -1/4 inch then discharge directly onto the tertiary crusher product screens located in series downstream from the crushers.

The tertiary crusher product screens separate the crusher product to 1/4 inch. The -1/4 inch screen undersize is discharged onto the fines collecting conveyors and transported to the retort feed storage silo. The 1/4 inch screen oversize material is collected on the recycle conveyor system and returned to the tertiary crusher feed surge hopper.

The -1/4 inch crushed oil shale that is collected from the scalping screens and the secondary and tertiary product screems are conveyed by the fines collecting conveyors to the retort feed storage silo.

Baghouse dust collectors control dust emissions during screening, crushing, and conveying of the raw oil shale. Dust pick-up hoods

.3 Crushing and Screening

will be incorporated at all dust generation points and draw through ducting to the collectors by induced draft fans. Bin filters will be located on the storage silo to allow air displacement by the incoming material and control dust at the silo. These systems are further discussed in section 6.8, Emissions.

.4 Retorting

The original Lurge Ruhrgas process developed in the fifties was for devolatillization of coal fines to produce high BTU fuel gas. Coal fines were contacted with a hot solid heat carrier producing an undiluted high quality fuel gas. The process has also been commercially modified to crack crude oil and naphtha to produce ethylene. Meanwhile, pilot plant tests confirmed the process suitable for tar sand extraction and oil shale retorting.

The LR process was selected over other surface technologies because of the following factors:

1. technology has proven high yields;
2. development is ready for commercial scaling;
3. equipment is proven for similar processes;
4. license does not involve competing U.S. energy companies.

The LR process oil shale retorting process can be subdivided into four sections:

1. Distillation and Circulation;
2. Waste Heat Recovery and Waste Gas Treatment;

.4 Retorting

3. Condensation; and

4. Heavy Oil Dedusting.

These four section constitute one LR process module. One module is comprised of two lift pipes, one collecting bin, two mixers, two surge bins and one each condensation train, waste heat recovery system, flue gas dedusting train and spent shale cooling train. Flow is depicted in the simplified block flow diagram EF-221.

As shown in Table 6.1, average raw shale production from the mine in Phase II totals 53,664TPCD (55,900TPSD). Seven LR modules rated at 7717.5 TPCD (8820 TPSD) could retort this production requiring only 359 TPCD stock pile make up. However, it is desirable to recover all the oil from the previously stockpiled shale. Consequently, an eighth LR module will be installed to increase site resource recovery.

The first module is scheduled to come on line July 1985. Additional modules will be added on six month intervals starting July 1987. Full capacity with eight surface modules is scheduled July 1990. Each new retort is operated at less than full capacity until proven, as shown in Table 6.2.

The combined availabiltiy of all mechanical equipment in the LR process results in an 87.5% availability factor. This means one module is operational 319 days per year. After July 1990, with eight installed LR modules, we can expect one module to be off line for service and maintenance at any given time.

TABLE 6.2 LR Module Retorting Capacity Schedule

Period/Module	1	2	3	4	5	6	7	8	TOTAL
1985 - Jan. 1986	50								50
1986 - July 1986	50								50
1986 - Jan. 1987	75								75
1987 - July 1987	75								75
1987 - Jan. 1988	100	50							150
1988 - July 1988	100	50	50						200
1988 - Jan. 1989	100	100	50	50					300
1989 - July 1989	100	100	100	75	50				425
1989 - Jan. 1990	100	100	100	100	100	67.5			567.5
1990 - July 1990	100	100	100	100	100	100	67.5		667.5
1990 - Jan. 1991	100	100	100	100	100	100	100	67.5	767.5
1991 -	100	100	100	100	100	100	100	100	800

SURFACE RETORTING

Retorting

Raw feed shale is conveyed from the feed silo to the feed surge bin across weigh belt feeders. Weights are totalized for accurate retort feed rate. A solids sampling device removes intermittant feed samples into a sample drum. The drum is blended and analyzed for the daily average oil grade.

.1 Distillation and Circulation

In the LR process oil shale retorting process, the heating meduim is hot spent shale residue at about 1240°F. It is intimately mixed with crushed incoming oil shale sized minus 1/4 inch in the screw mixer ratioed about 5 parts heating medium to 1 part raw shale. The incoming raw shale is heated to about 980°F within a few seconds. The kerogen completely decomposes into gas, oil and coke at this temperature.

The mixture discharges into a surge bin where kerogen decomposition and product diffusion are completed and the oil fraction vaporized. Distillation gases and vapor from the mixer and surge bin are dedusted in cyclones and then treated and recovered in the condensation section (6.4.3).

Spent shale discharges from the bottom of the surge bin into the lift pipes where preheated combustion air, about 800°F, pneumatically lifts the spent shale to the collection bin. The residual coke in the spent shale is burned with the preheated air during the pneumatic transfer, heating the spent shale to 1240°F for recycle to the mixer. Combustion of carbon residue in the spent shale is

.4 Retorting

.1 Distillation and Circulation (Continued)

sufficient to meet all the process heat requirements. A bleed stream of spent shale is removed from the collection bin to maintain proper balance of recirculating heat medium.

Gases discharging from the collection bin go to the waste heat recovery and gas treatment section.

Start up can be initiated with fine sand or previously discarded spent shale and an auxiliary lift pipe hydrocarbon fuel that is either gas or liquid.

.2 Waste Heat Recovery & Gas Treatment

The dusty waste combustion gases from the collection bin pass through the waste heat recovery system before finally being dedusted and discharged to the atmosphere.

Gases first pass through a hot gas cyclone to remove the majority of solids carryover. The solid stream is discharged into the spent shale discharge stream. The dusty gas at about 3.0 grains per standard cubic foot then passes through a heat exchanger to preheat the spent shale combustion air to 800°F and then through a waste heat boiler to produce 412 psig superheated steam at 540°F, 90°F superheat. Equipment problems with solids abrasion and erosion are minimized by flow path design and selected materials of construction. Reliability exceeds the expected stream factor. Dusty gas leaves the waste heat system at about 320°F.

4 Retorting

.2 Waste Heat Recovery & Gas Treatment (Continued)

The dusty gas is humidified and dedusted in an electrostatic precipitator before stack discharge to the atmosphere. The remaining dust content is projected to be approximately 0.06 grains per standard cubic foot. This is about 0.01 wt percent of the gas discharge. Efficiency of the electrostatic precipitator is expected to be about 98 percent. Dust from the electrostatic precipitator is mixed with spent shale.

.3 Condensation

Volatile products of oil and gas from the distillation section pass through two series-connected cyclones to reduce the entrained dust. The gases then pass to the scrubbing coolers. The first of these coolers operates at a high temperature to condense the heavy oil fraction and to remove any remaining dust. Heavy oil is recirculated through a closed loop cyclone to remove entrained liquid particles. Low velocities and hardened steels are used to minimize dusty oil abrasion.

The major oil condensation takes place dust free in the second scrubbing cooler or middle oil cooler. It operates above the dew point at 320°F so that the middle oil fraction is collected free of water. Recirculating middle oil is cooled by preheating boiler feed water prior to the waste heat boiler. The gas then passes through an air cooler where the majority of gas liquor, or process contaminated water, and the first light oil fraction are condensed. The second light oil

4 Retorting

.3 Condensation (Continued)

fraction is condensed by cooling to 95°F. Air and cooling water coolers are used to obtain the required process temperatures. The oil/water fractions are separated in gravity separators. The product gas still contains significant amounts of heavy ($C5^{+}$) hydrocarbons. These are recovered as a naphtha fraction by passing the gas through a light oil absorber. Naphtha is stripped from the rich oil and the oil recycled. Naphtha is mixed with the product oil or used as dedusting fluid, or used as fuel. The high BTU gas is used as a fuel in the 600 PSIG steam boilers.

.4 Heavy Oil Dedusting

Heavy oil product from the first scrubbing cooler requires further treatment in the heavy oil dedusting section. It consists of two stages of decanters and separators, a heavy oil fractionator and dust dryer. Incoming dust-laden heavy oil from the heavy oil scrubber is cooled and diluted with second stage separator clear naphtha. This diluted stream is processed in the first stage decanter and separator. Dust concentrate from the second stage decanter and separator is dried to recover recycle naphtha. Residue dust discharges to spent shale treatment. The clear oil fraction from the first stage decanter and separator is fractionated into recycle naphtha and dedusted heavy oil product.

0 SURFACE RETORTING

4 Retorting

.5 Products

The products of LR processing are gas, oil and water. Waste streams include waste gas and spent shale. Yields are dependant on feed assay. Table 6.3 shows the expected yields for the 24 GPT assay feed in Phase I and 30 GPT assay feed in Phase II for a single retort module. Oil yields are nearly 110 volume percent of the feed assay.

Oil production is the combined total of dedusted heavy oil, middle oil and light oil. Yield is reported to be 109.5 volume percent of the shale feed assay. The combined gravity is 27 degrees API with a 60°F pour point.

Gas liquor is the technical name of the process water condensed and produced with the light oil fraction. It has the following characteristics: pH, 9.2; ammonia content, 0.65 wt percent; and phenol content, 0.02 wt percent. Steam stripping is required prior to use as a spent shale moisturizer or waste gas humidifier.

Product gas has the composition shown in Table 6.4 The high heating value, 764 BTU/ft^3, makes the gas suitable for pilot fuel applications. Waste gas is the dedusted spent shale combustion gas. Excess air is provided to ensure complete combustion to CO_2. The resulting stream contains: 3.8 volume percent O_2, 17.1 percent CO_2, 0.1 percent CO, 79.0 percent N_2, 20 ppmv SO_2, no H_2S, 100 ppmv NO_x and 0.06 grain/SCF dust. The water dew point is 150°F and the dry molecular weight is 30.89.

TABLE 6.3 Lurgi Ruhrgas Single Module Oil Shale Retorting Yields

hale Grade	24 GPT			30 GPT		
	Nominal Rate	TPSD	WT%	Nominal Rate	TPSD	WT%
nput						
Oil Shale	8820 TPSD	8820	100	8820 TPSD	8820	100
utput						
Oil	5520 BPSD	858	9.7	6900 BPSD	1072	12.1
Product Gas, dry	7.33 MSCFD	251	2.8	9.16 MSCFD	314	3.6
water		9	0.1		11	0.1
Gas Liquor	20 gpm	120	1.4	25 gpm	150	1.7
Residue Dust from heavy oil	219 TPSD	219	2.5	219 TPSD	219	2.5
Waste Gas dry	146 MSCF	(6281)	-	146 MSCFD	(6281)	-
Carbon from coke		425	4.8		425	4.8
Dust		<1	-		<1	-
Spent Shale	6938 TPSD	6938	78.7	6629 TPSD	6629	75.2
Total Output		8820	100.0		8820	100.0

= Million

= 2000 lb ton

= 42 Gallon Barrel

CF @ 32°F

TABLE 6.4 Lurgi Ruhrgas Product Gas Composition

Component	Vot % Dry Basis
N_2	3.1
CO_2	25.12
H_2	31.5
CO	2.7
CH_4	15.0
C_2H_4	4.5
C_2H_6	5.4
C_3H_6	4.6
C_3H_8	2.9
i-C_4H_{10}	0.2
n-C_4H_{10}	1.0
C_4H_8	3.6
H_2S	0.07
SO_2	0.06
NH_3	0.25
Total	100

lecular Weight 24.61

gher Heating Value 764 BTU/cubic foot (60°F)

0 SURFACE RETORTING

5 Product Oil Storage and Shipping

The quantity of surface product shale oil depends on the number of modules operating and the quality of shale feed. Table 6.1 shows the expected surface retorting oil production as modules are installed from July 1985 through July 1990.

Daily oil production will be accumulated in rundown tanks sized for 24 hours holdup. These tanks ensure that intermediate product specifications are suitable for final product blending. These specifications include solids content, water content, gravity and pour point. The rundown tanks allow time for analytical tests prior to blending with other LR surface production and MIS production.

The combined MIS and LR Process oil yields are shown in Table 6.5. The final product is expected to be a combination of MIS and surface oil proportioned to their respective production yields. Physical properties such as gravity, pour point and distillation will vary as the proportion varies. Mixture properties such as vapor pressure, bottoms, sediment, solids and water will be controlled by the process to meet shipping specifications. Shipment will not be made from working tanks, where mixing and blending is ongoing. Rather shipments will be from blended, tested and accepted tanks.

Capacity of the tank farm will be sufficient to store approximately 10 days oil production while having one tank out of service for clean out and maintenance. A vapor recovery system will connect all the tanks. Vapors will be collected through condensing equipment.

6.5. Combined MIS and LR Surface Process Oil Production

Year)	MIS Production (BPCD)	LR Production (BPCD)	Total Oil Production (BPCD)
1985	0	0	0
	171	0	171
	1,751	2,415	4,166
	3,042	2,415	5,457
1986	4,929	2,415	7,344
	5,249	2,415	7,664
	9,019	3,620	12,639
	13,081	3,620	16,701
1987	20,779	3,620	24,399
	24,967	3,620	28,587
	28,046	7,245	35,291
	31,850	7,245	39,095
1988	36,926	9,660	46,586
	48,407	9,660	58,067
	54,306	14,490	68,796
	55,180	14,490	69,670
1989	54,800	20,530	75,330
	54,430	20,530	74,960
	54,050	27,410	81,460
	53,680	27,410	81,090
1990	53,300	40,300	93,600
	53,300	40,300	93,600
	53,300	46,340	99,640
	53,300	46,340	99,640
1991	53,300	48,300	101,600

MIS oil production
tract operation
tract oil production

.0 SURFACE RETORTING

.5 Product Oil Storage and Shipping

Condensate will be returned to a working tank; residual vapors will be injected into the retort product gas header to be burned as fuel.

.6 Spent Shale Conditioning

The processed shale and dust from the heavy oil dedusting system will be discharged from the retort facility onto a covered conveyor for transportation to the spent shale conditioning area. The -1/8 inch material will be discharged from the retort facility at approximately 140°F and a moisture content of approximately 1 percent by weight. The spent shale conveyor will discharge into surge bins by means of a belt tripper.

Gypsum (calucium sulfate) produced in the MIS flue gas desulfurization system at the surface process facility will be conveyed to the spent shale conditioning area via a covered belt conveyor, which discharges into surge bins by means of belt plows.

Spent shale conditioning is shown on block flow diagram EF-222. The gypsum and spent shale are withdrawn from their respective bins by belt feeders discharging into mixer-blenders for water addition. The total moisture content of the spent shale gypsum mixture will be sufficient to give the optimum properties for further handling and disposal. Water addition to achieve an estimated 10 percent by weight for the spent shale conditioning will range from approximately 100 GPM with one retorting module operating to 800 GPM with eight

.6 Spent Shale Conditioning

retorting modules on line. The gypsum will be blended with the spent shale as a convenient means of disposal as well as realizing any stabilizing effect it may have on the spent shale disposal pile. Blending capacity will be sufficient for addition of other stabilizing materials if required.

The spent shale/gypsum mixture will be discharged from the mixer/blenders onto a covered conveyor and transported to a truck loadout bin. From the truck loadout bin, the waste material will be trucked to the spent shale disposal area. The disposal system is discussed further in Section 7.0, Rock and Processed Shale Handling and Disposal. The expected material balance for spent shale conditioning is shown in Table 6.6.

Dust generated during the handling and conditioning of the spent shale will be controlled by a wet scrubber with dust pickup hoods at all points of generation. The dirty effluent from the scrubber discharge will be used in the mixer/blenders. Dust generated by the movement of mobile equipment will be controlled by a program of maintaining a wetted surface condition. Chemical stabilizers will be added to the water as required for optimum control. Dust control is further discussed in Section 6.8, Emissions.

.7 Utilities

The utilities required for surface retorting include electric power, various types of water, steam and drains. The requirements will be

TABLE 6.6 Processed Shale Conditioning

	Solids	Moisture	Total
Input, TPCD			
LR Process			
Processed Shale	46,403		
Residue Dust	1,533		
Subtotal	(47,936)	479	48,415
Flue Gas Desulfurization			
Gypsum	891	223	1,114
Incineration Ash			
Dry Solids	270	-	270
Water Addition	-	4,201	4,201
Total Input	49,097	4,903	54,000
Output, TPCD			
Blended Processed			
Shale for Disposal	49,097	4,903	54,000

.7 Utilities

met by installing capacity prior to the installation and operation of the LR retort modules between July 1985 and July 1990.

.1 Power

The main power for the surface retorting facility will be received from the surface process facility substation at 13.8 kV. Local substations and transformers will be fed by the 13.8 kV distribution system to reduce voltage to 4160 V or 480 V as required for areas and equipment. In plant distribution will be by underground lines. Power requirements range from 3000 kW at the start of surface retorting operations July, 1985 to 23,000 kW at full operation with eight modules in July 1990.

	One Module	Eight Modules
Crushing & Screening	1450 kW	11200 kW
Surface Retorting	1400	11200
Spent Shale Conditioning	150	600
Total	3000 kW	23000 kW

.2 Water

Water requirements for surface retorting facilities include process water, cooling water, boiler feed water, potable water and fire water. All water is assumed to be 8.33 lb/gal.

Process Water Process water is required for three separate functions: raw shale dust suppression, retort offgas humidification and spent shale wetting and conditioning. The estimated process water consump-

Utilities

.2 Water (Continued)

tion ranges from 276 GPM during one retort module operation to 2208 GPM during eight module operation, excluding dust suppression applications.

	One Module	Eight Modules
Off gas Humidification	176 GPM	1408 GPM
Spent Shale Conditioning	100	800
Total	276 GPM	2208 GPM

Cooling Water Cooling water supply is required by each retort module at 2400 GPM and 68°F. It is returned at 95°F to a cooling tower located near the retorting area. Approximately 3 percent of total flow, or 72 GPM per module, is required as make up for evaporation and blow down loss.

	One Module	Eight Modules
Circulation	2400 GPM	19200 GPM
Make Up	72 GPM	576 GPM

Boiler Feed Water Boiler feed water is related to the retort steam balance. The gross amount must supply the unit steam production and blowdown. The net makeup, however, is off set by that portion of steam used within the module battery limits, condensed and recycled. Net make up ranges from 93 GPM for one retort module to 744 GPM for eight retort modules.

Utilities

.2 Water (Continued)

Module users include steam turbine divers, steam tracing, heavy oil/naphtha fractionation and residue dust drying. Approximately 5 percent of the gross steam production is allowable loss and blowdown. Steam production is shown as equivalent gallons per minute to simplify the boiler feed water balance. Boiler feed water is preheated in the middle oil scrubber cooler section to maximize system heat recovery.

	One Module		Eight Modules	
Boiler Output	GPM	Klb/hr	GPM	Klb/hr
Export Steam	86	43	688	344
Module Use Steam	64	32	512	256
Sub total	(150)	(75)	(1200)	(600)
Blowdown	2	1	16	8
Total Output	152	76	1216	608
Boiler Input				
Module Consdensate Return	59	29.5	472	236
Makeup				
Loss	5	2.5	40	20
Export Steam	86	43	688	344
Blowdown	2	1	16	8
Subtotal Makeup	(93)	(46.5)	(744)	(372)
Total Input	152	76	1216	608

Utilities

.2 Water (Continued)

Potable Water. Potable water for use as drinking water, personal comfort stations and safety showers, will be available as required. Maximum use in the surface retorting area is estimated at 100 GPM.

Fire Water A fire protection water loop system with strategically located hydrants and monitors will be installed to meet all safety codes and insurance underwriters criteria for safe operation of the facility.

.3 Steam

During retorting of the oil shale, superheated steam at 412 psig and 540°F is produced in the waste heat boiler. As previously shown in the boiler feed water discussion, one module produces 75,000 lb/hr and eight modules produce 600,000 lb/hr. Approximately 43,000 and 344,000 lb/hr respectively is available for use in the MIS retorts.

The remainder is used within the module for steam turbine drivers, steam tracing, heavy oil/naphtha fractionation and residue dust drying. Clean condensate is reused as boiler feed water.

.4 Drains

Industrial, sanitary and storm runoff drains and sewer systems will be provided. Flow is directed to the appropriate surface

Utilities

.4 Drains (Continued)

process facility for treatment. Boiler blowdown maintains the+ appropriate dissolved solids concentration; discharge is routed to the excess water evaporator to further concentrate the solids (brines) prior to disposal in the flue gas desulfurization system.

Emissions

Surface retorting emissions involve shale handling transfer points and retorting process discharges. Shale handling transfer points include belt conveyors, material stockpiling areas, crushing and screening transfer points, retorting and spent shale conditioning areas. All of these will be protected by baghouses thereby reducing particulate emissions to a minimum.

The Lurgi surface retorting waste gas does discharge measureable emission quantities. Table 6.7 shows the estimated discharges from initial retort operation through eight module operations. Quantities are based on the waste gas analyses in Section 6.4.5 and the retorting yields from Table 6.2 for particulate matter, sulfur dioxide, nitrogen oxides and carbon monoxide.

Particulate Matter The waste gas solids content is expected to be 0.06 grains per standard cubic foot for 98 percent efficient electrostatic precipitation. Discharge will range from 52 to 416 pounds per hour for one to eight operating modules.

Emissions

Sulfur Dioxide. The SO_2 content is expected to be 20 volume ppm in the waste gas. Discharges range from 21.7 to 174 pounds per hour for one to eight operating modules.

Nitrogen Oxides Nitrogen oxides are reported as nitrogen dioxide for control purposes. They are generally formed during severe oxidation conditions. The LR Process avoids such severe conditions. Discharge is expected to be 100 volume ppm in the waste gas. The range of 78 to 624 pounds per hour for one to eight operating modules is expected to be well within allowable discharge limits.

Carbon Monoxide The 0.1 volume percent carbon monoxide represents the largest polutant emission for Lurgi retorting. Even the excess combustion air does not eliminate the carbon monoxide. Discharge will range from 474 to 3,792 pounds per hour for one to eight operating retorts.

Wetting the spent shale with 10% moisture will eliminate particulate emissions from the spent shale as such. Wind erosion dust emissions and road dust hauling emissions will be controlled by spray systems. These quantities will be identified with the surface emission summary in chapter 10.

TABLE 6.7 Lurgi Surface Retorting Emissions

Operating Retorts	Waste Gas Polutant Emissions, Pounds per Hour			
	Particulate	Sulfur Dioxide	Nitrogen Oxides	Carbon Monoxide
1	52	21.7	78	474
2	104	43.4	156	948
3	156	65.1	234	1,422
4	208	86.8	312	1,896
5	260	108.5	390	2,370
6	312	130.3	468	2,844
7	364	152.0	546	3,318
8	416	173.7	624	3,792

Emissions based on full retort operating capacity.

.0 ROCK AND PROCESSED SHALE HANDLING AND DISPOSAL

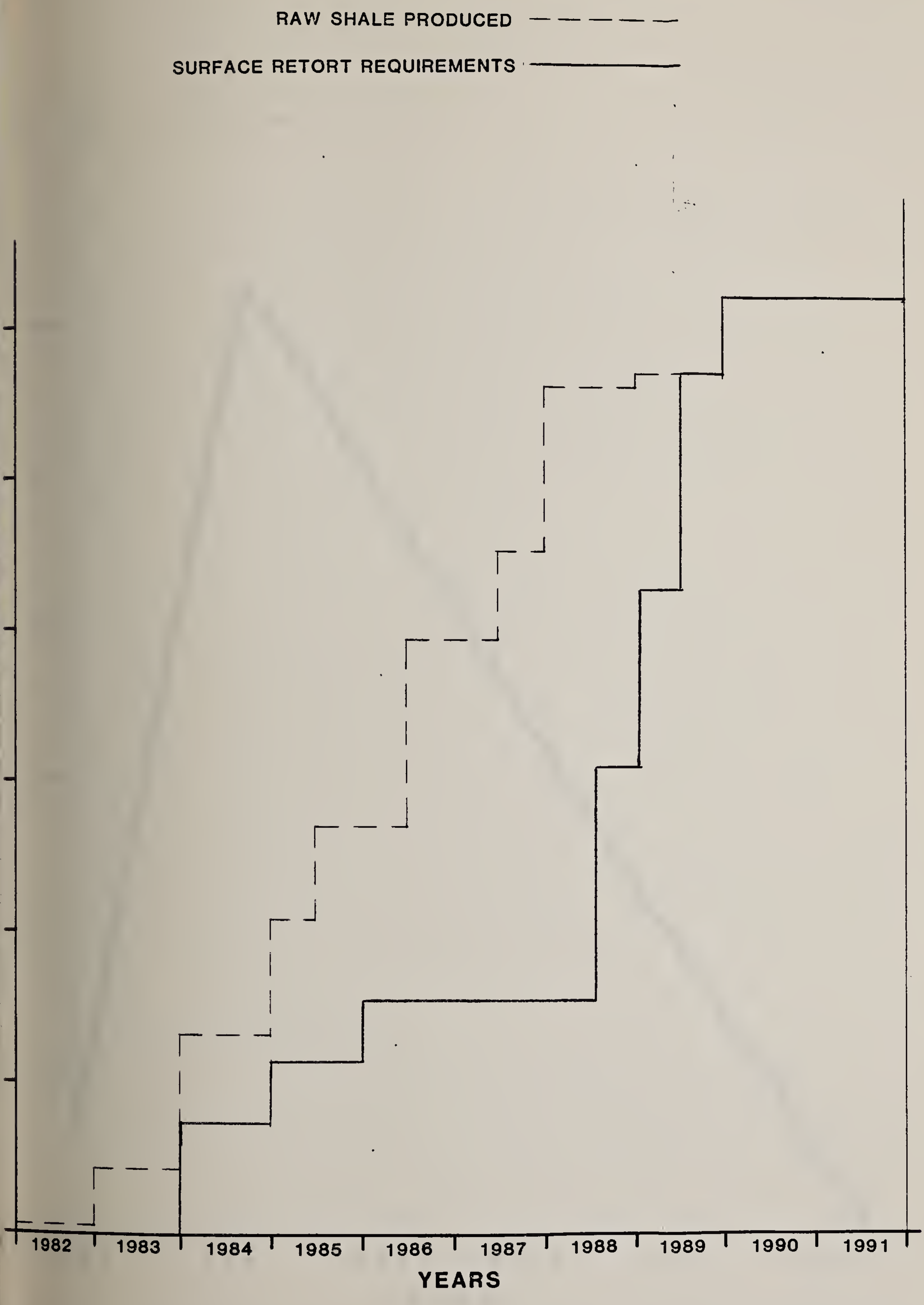
.1 Raw Shale Handling and Disposal

.1 Introduction

When mining begins in 1982, and prior to full surface retorting capacity reached in late 1989, the quantity of raw shale produced exceeds the amount needed to satisfy surface retorting requirements. Figure 7.1 graphically illustrates this difference. As shown in the figure, while the surface retorting facility builds from one to eight operating modules (1984 - 1989), more shale is produced than needed for surface retorting. During this time, a raw shale stockpile is developed to contain the excess.

The stockpile builds at the rate depicted in Figure 7.2. As shown, the pile develops rapidly as the mine approaches a production rate of 59,000 tons per stream day (56,640 tons per calendar day) in 1988. Phase II production of 55,000 tons per stream day (53,664 tons per calendar day) starts in 1990. After seven surface retorts are activiated, the quantity of raw shale needed exceeds the amount produced from the mine and, consequently, raw shale is removed from the stockpile to supplement mine-produced shale. Current projections indicate that the raw shale stockpile will be depleted in 2011 (see drawing EM-119 thru 126).

This section discusses the design, sizing, and handling of the raw shale stockpile from its inception through final reclamation activities.



7.1 RAW SHALE PRODUCED AND SURFACE RETORT REQUIREMENTS

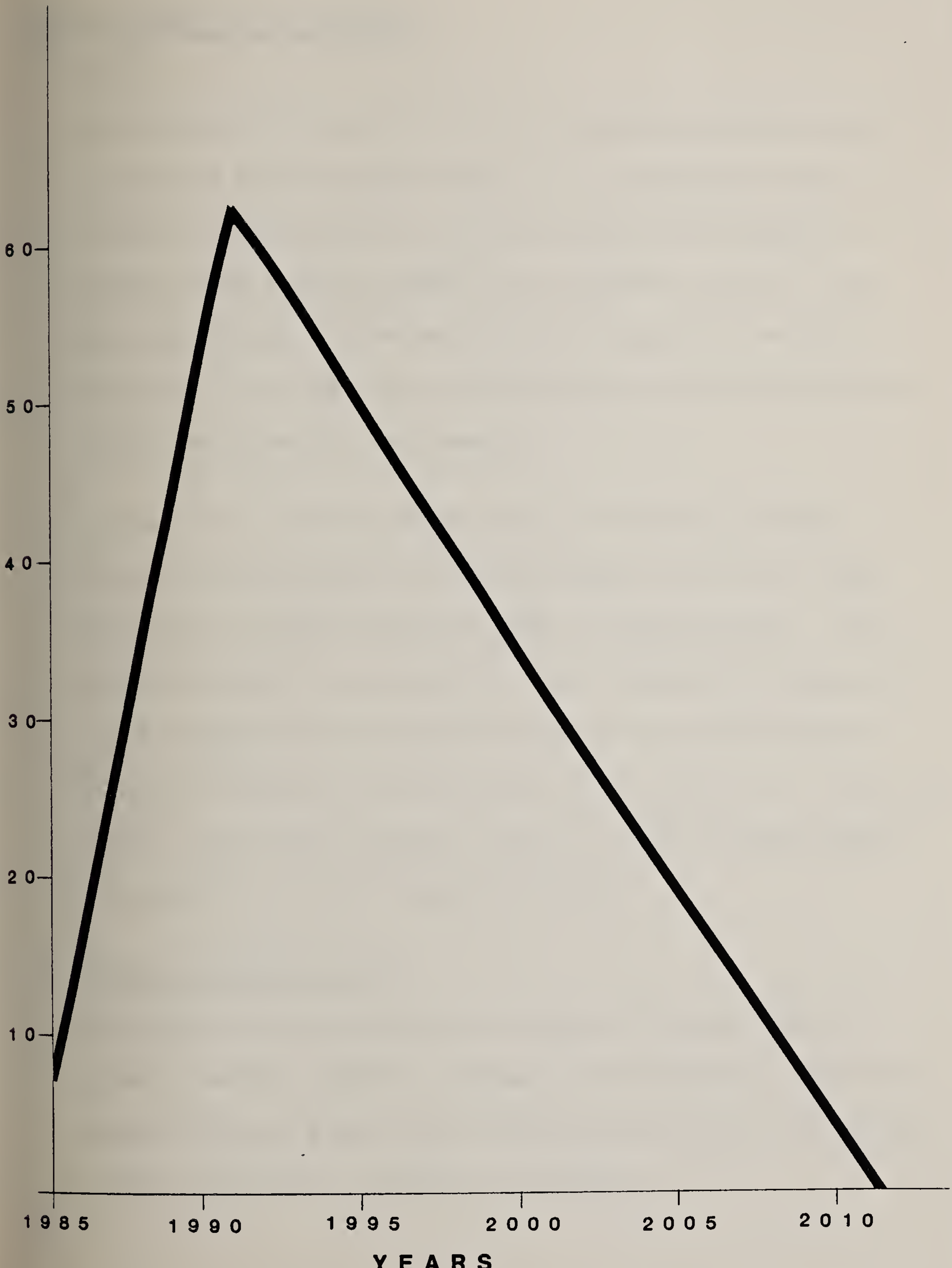


Figure 7.2 RAW SHALE STOCKPILE VOLUME

.0 ROCK AND PROCESSED SHALE HANDLING AND DISPOSAL

.1 Raw Shale Handling and Disposal

.2 Site

Raw shale will be stored entirely in Cottonwood Gulch as shown on drawings EM-119 through EM-126. This area provides an ideal storage site since it will hold the entire volume of shale without extending above the surrounding terrain. Also, the upper reaches of Cottonwood Gulch lie entirely on-site, resulting in a relatively small watershed which minimizes water control and diversion requirements.

Scrapers will initially remove topsoil from the raw shale storage site and deposit it on the storage pile on the ridge just east of Scandard Gulch as shown on drawing EM-119. This soil will remain in storage until final reclamation of the raw shale stockpile area during the latter years of the project. During the time that the raw shale pile is active, i.e., initially growing and finally receding, topsoil will be stripped ahead of the advancing pile and temporarily stored.

.3 Storage Pile Development

Raw shale will be transported to disposal from the material going to surface retorting. Because the raw shale is damp as it emerges from the mine, excess dust should be minimal when dumped in the storage pile. However, if fugitive

.0 ROCK AND PROCESSED SHALE HANDLING AND DISPOSAL

.1 Raw Shale Handling and Disposal

.3 Storage Pile Development (Continued)

dust is generated a wetting system will be provided. Bulldozers will push raw shale onto the working face and shape side slopes to 4 (horizontal) to 1 (vertical). Since there is a possibility of spontaneous heating of the raw shale pile, compaction may be required to limit air necessary to sustain the exothermic reaction.

Because of the temporary nature of the raw shale stockpile, it will not be covered with topsoil and revegetated. Instead, an environmentally acceptable chemical stabilizer will be used to control pile erosion. This will eliminate excessive handling of topsoil and reduce the amount of topsoil lost due to rehandling.

.4 Pile Consumption

Consumption of the raw shale stockpile will begin at the south end and progress northward. The deeper northern sections will be worked in benches on an east and west half-face basis. Front-end loaders will load the material in trucks for transfer to a hopper bin arrangement that feeds a conveyor system to the surface retorts. Truck haulage roads for the operation will be on the east and/or west sides. Water sprays will be used for dust suppression during the consumption phase.

.0 ROCK AND PROCESSED SHALE HANDLING AND DISPOSAL

.1 Raw Shale Handling and Disposal

.4 Pile Consumption (Continued)

As the pile is being depleted, the topsoil from the topsoil storage pile is used to reclaim the area originally occupied by the raw shale stockpile. There, the soil is graded and revegetated.

.5 Water Diversion and Control

Control and diversion of water on and around the raw shale pile will be necessary only until the pile is depleted in 2011. Reclamation will return the stockpile area to an environmentally acceptable condition.

Runoff from the east and west sides of the pile will flow into ditches that will carry water to a catchment dam across Cottonwood Gulch near the northern boundary of the tract. These ditches will be engineered so as not to allow undercutting the toe of the pile. The reservoir will be either a sedimentation or treatment pond, and any water discharged will conform to NPDES standards (see Section 9.2).

Precipitation running off the southern end of the pile and the rest of the water in the Cottonwood Gulch watershed above the pile will be deverted around the pile via a lined ditch to the same catchment dam across Cottonwood Gulch. This is shown on drawing EM-119.

.0 ROCK AND PROCESSED SHALE HANDLING AND DISPOSAL

.2 Processed Shale Handling and Disposal

.1 Production Quantities

When the surface retorts are brought on line and individually reach full production, each retort will produce processed shale at 6,629 TPSD and treated heavy oil residue dust at 219 TPSD. Water, gypsum, and plant incinerator ash will be mixed with the processed shale in the Processed Shale Handling and Treatment Building prior to being transported to the disposal area as discussed in Section 6.6. Table 7.1 identifies the total quantity of materials mixed and blended with the processed shale that results in an average yield of 7,714 TPSD from each surface retort.

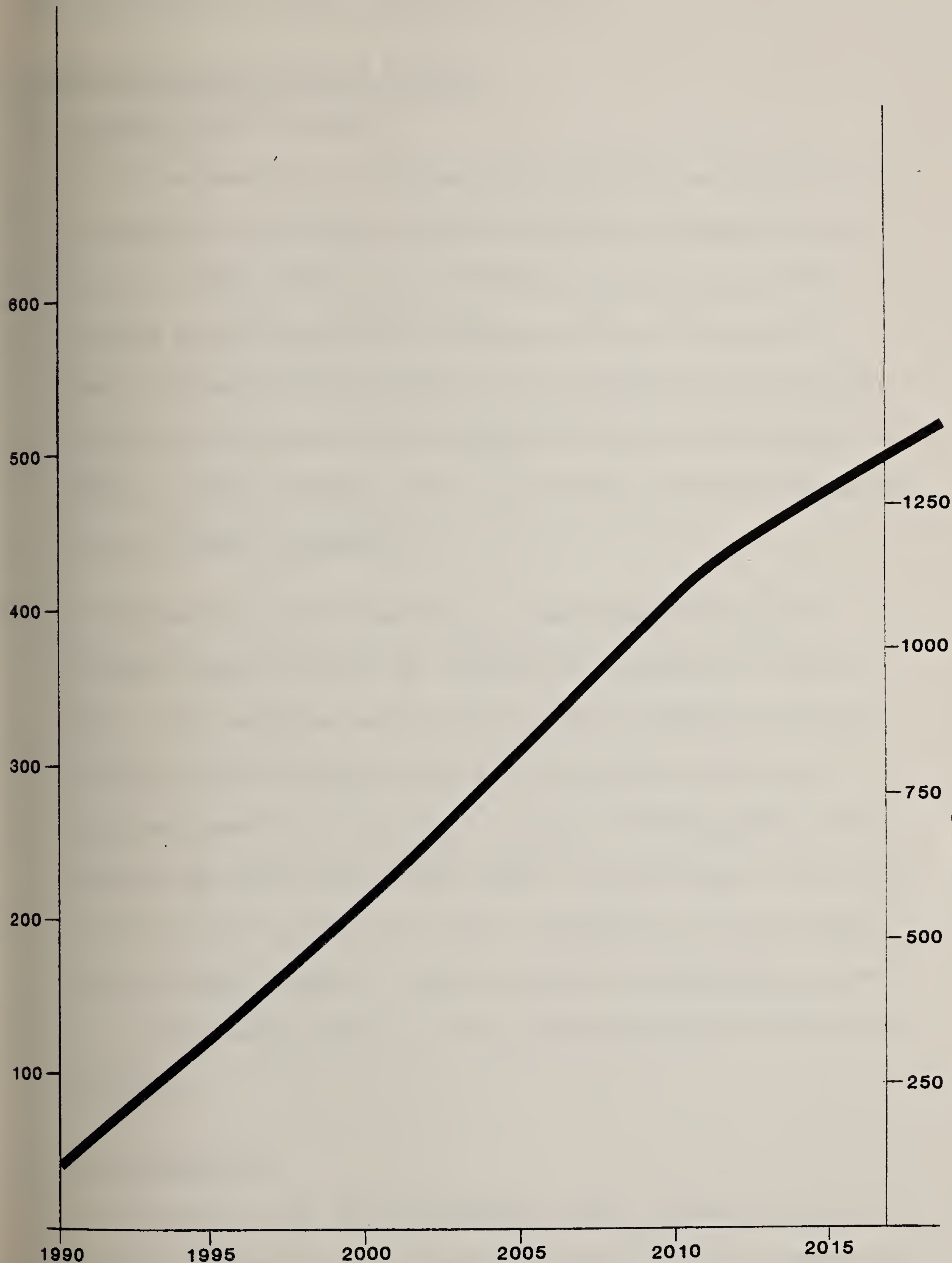
All the shale produced during mine development will be processed in the surface retorts, which results in an approximate quantity of 505 million tons of processed shale (see Figure 7.3). Using an in place compacted density of 90 pounds per cubic foot, this results in a final volume of 415 million cubic yards.

.2 Disposal Site

Several on-tract areas were evaluated as the potential location of the processed shale disposal pile. Sorghum Gulch, drawings EM-119 through EM-128, is the preferred location due to the proximity to treatment facilities, the small watershed above the proposed site, and the capability of constructing the pile so processed shale will not extend beyond the ridge line into Stewart Gulch.

Table 7.1 Processed Shale Conditioning

terial Source		One LR Retort TPSD	One LR Retort TPCD	Eight LR Retorts TPSD	Eight LR Retorts TPCD
rgi Retorting					
Processed Shale		6629	5800	53032	46403
Residue Dust		219	192	1752	1533
Moisture, 1%		68	60	546	479
sulfurizer					
Gypsum		127	111	1018	891
Moisture		32	28	254	223
cinerator					
Ash		39	34	308	270
ter Addition		600	525	4800	4201
	TOTAL	7714	6750	61710	54000



gure 7.3 GROWTH OF THE PROCESSED SHALE DISPOSAL AREA

.0 ROCK AND PROCESSED SHALE HANDLING AND DISPOSAL

.2 Processed Shale Handling and Disposal

.2 Disposal Site (Continued)

Due to the quantity of processed shale handled, the disposal pile will extend approximately 240 feet above the surrounding terrain and will likely stretch most of the way to the north property boundary and ultimately into Cottonwood Gulch to the west as shown on drawing EM-127. However, the selection of Sorghum Gulch minimizes the conveyor/ truck haulage distance, which lessens the impact on the environment, and also provides the best arrangement from an economic standpoint.

An alternative to this configuration would be to place the processed shale off-tract to the south in the head of Sorghum Gulch. This would not only provide a larger disposal area and thereby lower the height of the pile, but would provide the additional benefit of filling in the upper tributary area and reducing the effects of surface runoff on the disposal area. At present, this alternative is being considered and is contingent upon government approval. For the purpose of this plan, however, it will be assumed that all of the processed shale will remain on the tract.

.3 Site Preparation

The reclamation plan for the processed shale disposal area calls for covering the pile with topsoil as soon as practical after the pile reaches its final size in any area. Initial preparation of

the disposal site will entail removing topsoil or soil-like material from the area where the processed shale will first be deposited and creating a topsoil stockpile in the Scandard Gulch area as shown on drawing EM-119. This topsoil pile will be revegetated for storage until the end of the project and then will be used for reclaiming the final portion of the processed shale disposal pile in Cottonwood Gulch. As the processed shale disposal area progresses through the life of the project, topsoil will be stripped ahead of the advancing pile and either immediately deposited on completed portions or temporarily stored for reclamation purposes as described in Section 9.10.4.

.4 Disposal Practices

Processed shale emerges from the surface retorts as a fine, powdery material (-1/8 inch) with a moisture content from 1 to 2 percent at a temperature of approximately 140°F. A covered conveyor moves the shale to the Processed Shale Handling and Treatment Building where gypsum from the Gas Treatment Facility, ash from the incinerator, and water for proper compaction and dust control at about 10 percent by weight are blended with the processed shale.

Transfer to the Disposal Pile. Covered belt conveyors, designed to retard moisture loss and prevent fugitive dust generation, carry the treated processed shale overland from the treatment

.4 Disposal Practices (Continued)

facility to load-out hoppers. The conveyors are built on a strip of land sufficiently wide to provide access via a service road for conveyor inspection and maintenance. As the pile grows, both roads and the conveyors will be extended on to the compacted processed shale. If a system failure forces a shutdown, an emergency conveyor is activated that will dump the blended shale outside the treatment building. Trucks would then haul this material to the dump site.

Processed shale will be transferred by 120-ton, diesel-powered end-dump trucks from the load-out hoppers to the disposal pile. The trucks will dump the load while moving in the working area. Graders will shape the material into lifts of 12 to 18 inches. Self propelled, segmented wheel compactors will be used to provide compaction in addition to the loaded truck traffic. In a study done for the Colony Project E.I.S., this type of compaction was found to deliver maximum performance and the highest capacity.

Shaping the Processed Shale Pile. As shown in drawing EM-120, construction of the processed shale pile will begin south of the shale oil tank farm due to the proximity of the processed shale handling and treatment building. During pile development, the conveyor and load-out facility will be periodically moved to minimize haul distance. After approximately two years of

2 Processed Shale Handling and Disposal

.4 Disposal Practices (Continued)

retorting, pile elevations along the west slope will reach the final configuration. At this time, the overland conveyor belt and the load-out facility will be set up on top of the pile. They will then be developed southwards with the western slope and top-of-pile elevation brought to the final configuration. Upon reaching the southern boundary, the pile will be developed eastwards along its entire length. When the final configuration is reached at the east Sorghum Gulch ridge, pile development will progress northward. Drawings EM-120 through EM-127 show the pile in progressive stages. As the disposal pile reaches its final elevation, the surface will be shaped or sculptured in a pattern similar to that of contour farming. This will minimize water runoff and capture water beneficial to plant and animal life both during and after the revegetation period. The final configuration will provide for safe movement and shelter of wildlife.

The active face of the disposal pile will be built-up using a multiple bench arrangement. Benches are spaced a maximum vertical distance of 100 feet and will be 100 feet wide to provide an adequate turning radius for dump trucks.

Haul roads will provide access from the truck load-out facility to the benches. These roads are at least 100 feet wide to provide safe two-way traffic at normal operating speeds.

2 Processed Shale Handling and Disposal

.4 Disposal Practices (Continued)

For greatest climbing and descending efficiency, haul roads will not exceed 8 percent slope. Outslope safety berms will be constructed as well as median berms on sloping two-way stretches. To suppress dust on haul roads, a water truck with a sprinkler system may be used. Water will be added in a quantity sufficient to suppress dust, but not to the point where a muddy or slippery surface is produced.

Dust Control on the Working Face. Studies indicate that no more than 50 acres on the working face of the processed shale pile should be exposed at any one time to maintain air quality standards. Dust suppression measures will be necessary for the pile due to the size of the face. The inactive area of the working face will be sprayed with an inert asphaltic emulsion (or equal material) to suppress dust. Vehicular traffic will be banned from this area to prevent the dust barrier from being destroyed.

Pile Reclamation. Usable topsoil and sub-soil material will be removed in front of the advancing processed shale pile and stockpiled clear of the filling operations relatively close to the pile reclamation area. Erosion control structures will be in place before clearing begins. At regular intervals during pile development, all exposed surfaces of the pile will be covered

7.0 ROCK AND PROCESSED SHALE HANDLING AND DISPOSAL

7.2 Processed Shale Handling and Disposal

.4 Disposal Practices (Continued)

with 12 to 18 inches of soil and seeded according to accepted environmental standards, as discussed in Section 9.10. The final configuraion for the pile side slopes consists of a nominal four (horizontal) to one (vertical) with 25-ft wide benches cut every 30 feet of elevation. These benches will be reverse-sloped to catch any runoff from the sides of the pile. Drawing EM-128 shows the final configuration of the processed shale disposal area after reclamation activities are complete in 2033.

Extensive planning and organization will be necessary to obtain a satisfactory balance between economical operations, safety, and environmental considerations when building and reclaiming the processed shale pile. Coordinating the loading and dumping patterns, establishing usable haul roads, maintaining operations on multiple benches to average out haul distances, staying within established face limits, moving conveyors and load-out facilities in a timely manner, and stripping and reclamation activities will all be considered when developing a detailed design for the processed shale disposal area. This detailed design will be submitted to the OSO for inclusion in the DDP prior to first use of the processed shale disposal area.

0 ROCK AND PROCESSED SHALE HANDLING AND DISPOSAL

2 Processed Shale Handling and Disposal

.5 Water Diversion and Control

Water runoff from the processed shale disposal pile will be minimized in an attempt to capture water that will assist in revegetation. As topsoil is applied to the area, a series of interceptor ditches to catch the surface runoff will be sculpted into the pile outslopes. These ditches will drain into the lined ditch that will be constructed around the entire circumference of the pile. The lined ditch will have evenly-spaced earthen dams that will further contain runoff at the base of the pile as water flows from the south to the north.

Three catchment reservoirs will be constructed to contain runoff during heavy rains, with a 100-year, 24-hour storm being the design storm (Figure 7.4 shows the rainfall frequency that can be expected at Tract C-b). One reservoir will be located at the south end of the pile, at the tract border, and will collect runoff from the south slope and the off-tract head of Sorghum Gulch. The second catchment will be constructed near Exhaust Shaft No. 2 to collect water from the west side of the pile. Reservoir No. 3 will be built across Sorghum Gulch at the northern boundary of the tract and will receive runoff from the eastern slope via the lined ditch. A 36-inch diameter concrete culvert will be constructed to allow water to flow from the first two reservoirs to the catchment dam at the north edge of the tract. This will prevent runoff accumulations from percolating into the

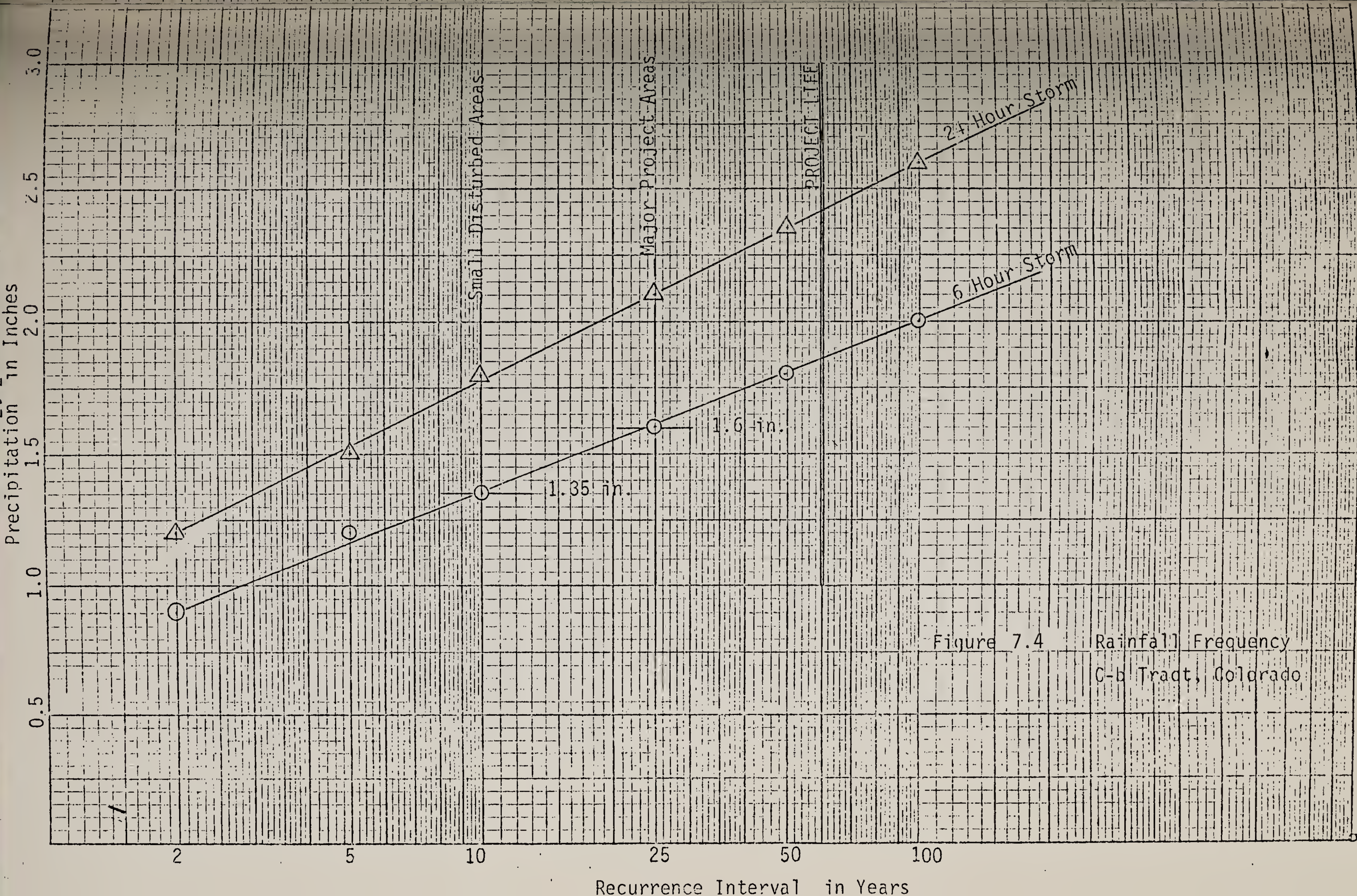


Figure 7.4 Rainfall Frequency

C-b Tract, Colorado

2 Processed Shale Handling and Disposal

.5 Water Diversion and Control (Continued)

ground and possibly leaching through the processed shale pile at the two southernmost reservoirs. Computer modeling of the 36-inch-diameter pipeline indicates that runoff from a 100-year, 24-hour storm will flow from the first two reservoirs to the northern catchment in less than 24 hours after runoff begins. Drawing EM-127 shows the overall drainage plan.

Any water that must be discharged from the tract will be in compliance with the state-administered NPDES permit. This is further explained in Section 9.2.

.3 Chemical and Physical Characteristics

.1 Raw Shale Chemical Properties

Mined shale has varying oil content. Although nearly constant for a narrow shale interval, changes nearby and throughout the tract significantly affect chemical and physical properties. Generalized information for Green River oil shale, reported in Cameron Engineers' "Synthetic Fuels Data Handbook, Second Edition," 1978, is also referenced for comparison.

Fischer Assay. The standardized procedure for determining a given oil shale yield is known as Fischer Assay. A fixed sample is heated at a controlled rate in an inert atmosphere. The oil yield is collected and reported in gallons per ton of raw shale.

3 Chemical and Physical Characteristics

.1 Raw Shale Chemical Properties (Continued)

$$FA = gpt \quad (1)$$

Metric units express oil yield in liters/metric ton, liters/tonne, or liters/Mg; all are equivalent.

$$4.171 \times FA, \text{ gpt} = \text{liters/metric ton} \quad (2)$$

English units, gpt, will be used throughout this section

Kerogen. The organic material in oil shale, called kerogen, is composed of carbon, hydrogen, nitrogen, sulfur, and oxygen. Upon sufficient heating, kerogen decomposes into gas, oil, and residual coke. The kerogen relationship to Fischer Assay is:

$$\text{Kerogen, wt\%} = 0.5 \times FA + 2.0, \text{ Cameron} \quad (3A)$$

$$= 0.56 \times FA + 0.433, \text{ C-b} \quad (3B)$$

Heating Value. Oil shale can be burned in a calorimeter to determine the heating value. The gross heating value of raw shale is shown to be:

$$\text{HV raw shale, BTU/lb} = 93.3 \times FA, \text{ Cameron} \quad (4)$$

Mineral Content. The mineral content reported by Cameron is as follows:

0 ROCK AND PROCESSED SHALE HANDLING AND DISPOSAL

3 Chemical and Physical Characteristics

.1 Raw Shale Chemical Properties (Continued)

Mineral	Chemical Formula	Wt%
Dolomite	$(Mg,Fe)\ Ca\ (CO_3)_2$	32
Calcite	$CaCO_3$	16
Quartz	$Si\ O_2$	15
Illite	$KAl_2\ (AlSi_3)\ O_{10}\ (OH)_2$	19
Albite	$Na\ Al\ Si_3\ O_8$	10
K feldspar	$K\ Al\ Si_3\ O_8$	6
Pyrite	FeS_2	1
Analcime	$NaAl\ SiO_4 \cdot\ 25H_2O$	1
		100

The mineral content of raw shale from Tract C-b will be provided for inclusion in the DDP when available.

Weathering. According to Cameron, prolonged exposure of mined Green River oil shale reduces oil yield and increases water yield. Five years direct weathering decreased oil yield 11 percent and increased water yield nearly 90 percent. Raw shale stockpile storage, discussed in Section 7.1.3, will be covered with a chemical stabilizing agent to reduce direct exposure losses.

.2 Raw Shale Physical Properties

Mining methods and shale handling equipment determine the maximum size and size distribution of raw shale. Feeder breakers will produce material sized less than 8 inches. Particles tend

0 ROCK AND PROCESSED SHALE HANDLING AND DISPOSAL

3 Chemical and Physical Characteristics

.2 Raw Shale Physical Properties (Continued)

to break along bedding planes and are slab-like. A typical size distribution for C-b Tract run-of-mine shale is shown in Figure 7.4, with an average size of 4 inches.

Specific Gravity. C-b Tract data and Cameron data differ slightly for in-place gravity due to the greater moisture content for C-b Tract shale.

$$\text{SpGr raw shale} = 3.263 - 0.178\,(11.74 + FA)^{1/2}\text{, Cameron} \quad (5A)$$
$$= 2.519 - 0.013\,FA\text{, C-b} \quad (5B)$$

Specific gravity ranges from 2.10 to 2.25 for C-b shale.

Bulk Density. Mined shale has a void fraction ranging typically from 35 to 50 percent. Bulk density is the weight of material (pounds) per cubic foot handled, including voids.

$$\text{Bulk Density, lb/ft}^3 = 62.4 \times \text{SpGr} \times (1-E) \quad (6)$$

Where E = Void fraction, 0.35 to 0.5

Enthalpy. Also called heat content, enthalpy is the heat relative to a standard temperature. It is also the product of specific heat and the temperature difference from standard. Based on Cameron data and 77°F standard temperature:

$$\text{H raw shale, BTU/lb} = [0.172 + (6.7 + 0.167 \times FA) \times (t + 460)10^{-5}] \times (t-77) \quad (7)$$

Where t = temperature, °F

Specific heat at 77°F ranges from 0.22 to 0.24 BTU/lb°F for C-b Tract shale.

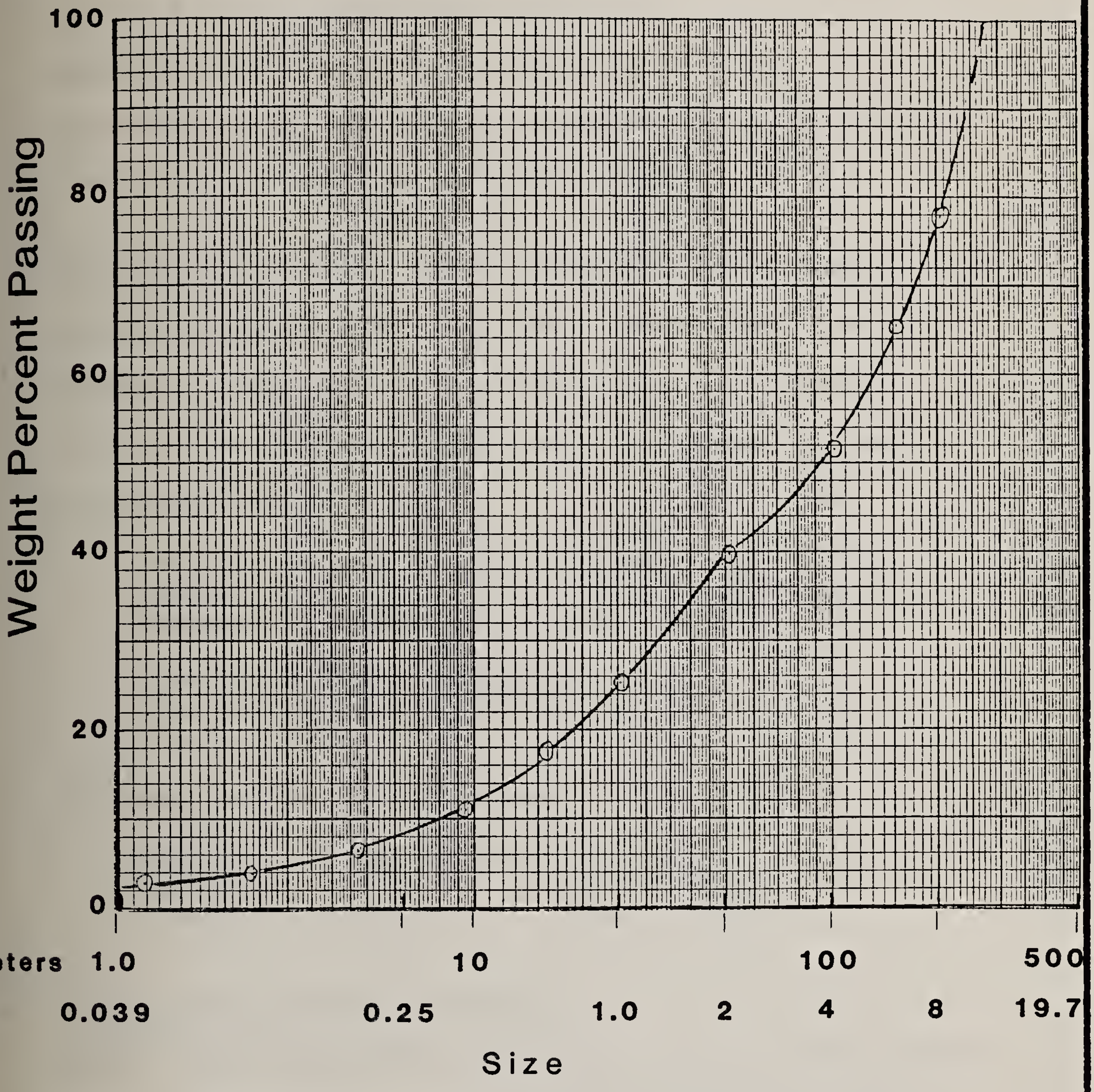


Figure 7.4

RAW SHALE PARTICLE SIZE, C-b RUN OF MINE

Chemical and Physical Characteristics

.2 Raw Shale Physical Properties (Continued)

Angle of Repose. The angle of repose for mined C-b oil shale is approximately 38°. It will vary depending on size distribution, void fraction, compaction and particle shape.

Mechanical Properties. Other oil shale physical properties from Occidental data include shear stress, compressive strength, hardness, elastic modulus, cohesion, and angle of internal friction. The C-b shale values are listed below; some are related to shale grade:

$$\text{Angle of Internal Friction, degrees} = 59.3 - 0.952\ FA \quad (8)$$
$$\text{Cohesion, psi} = 2330 + 32.9\ FA \quad (9)$$
$$\text{Compressive Strength, psi} = 38000 - 1220\ FA + 12.5\ FA^2 \quad (10)$$

Tensile Strength = 1,000 psi
Elastic Modulus = 1,000,000 psi
Poisson's Ratio = 0.3

The ranges for C-b Tract shale are:

Angle of Internal Friction,	30 to 38°
Cohesion,	3000 to 3400 psi
Compressive Strength,	12000 to 16000 psi

.3 Processed Shale Chemical Properties

Lurgi's direct combustion retort yields a burned shale light in color, low in residual carbon, and containing calcuim and magnesium oxides with cementing properties.

.3 Chemical and Physical Characteristics

.3 Processed Shale Chemical Properties (Continued)

Composition. The mineral content for actual Lurgi retorted C-b shale is reported as follows:

	Wt. %
Silicon dioxide, SiO_2	43.9
Iron as FeO	4.2
Aluminum as Al_2O_3	12.1
Calcium as CaO	21.4
Magnesium as MgO	4.6
Sulfur as SO_4	3.6
Sodium as Na_2O	3.0
Potassium as K_2O	2.6
Carbon dioxide as CO_3	4.4
Organic carbon	0.2
Total	100.0

The chemical composition of a standard 1:10 leach for the retorted shale is summarized below:

	Milligrams/liter
Potassium chloride KCl	40
Sodium chloride NaCl	15
Sodium sulfate Na_2SO_4	754
Magnesium sulfate $MgSO_4$	302
Calcium sulfate $CaSO_4$	1500
Calcium carbonate $CaCO_3$	150
Calcium silicon oxide $CaSiO_3$	35
Calcium Hydroxide $Ca(OH)_2$	951

The remitting pH was 11.7

Other trace elements have also been identified in various retorted shales. The list includes, but is not limited to: antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, lithium, manganese, mercury, molydemum, nickel, selenium, titanium, vanadium, zinc and zirconium. Other anions include cyanide and fluoride. Analytical tests of these elements for Lurgi retorted shale are not available.

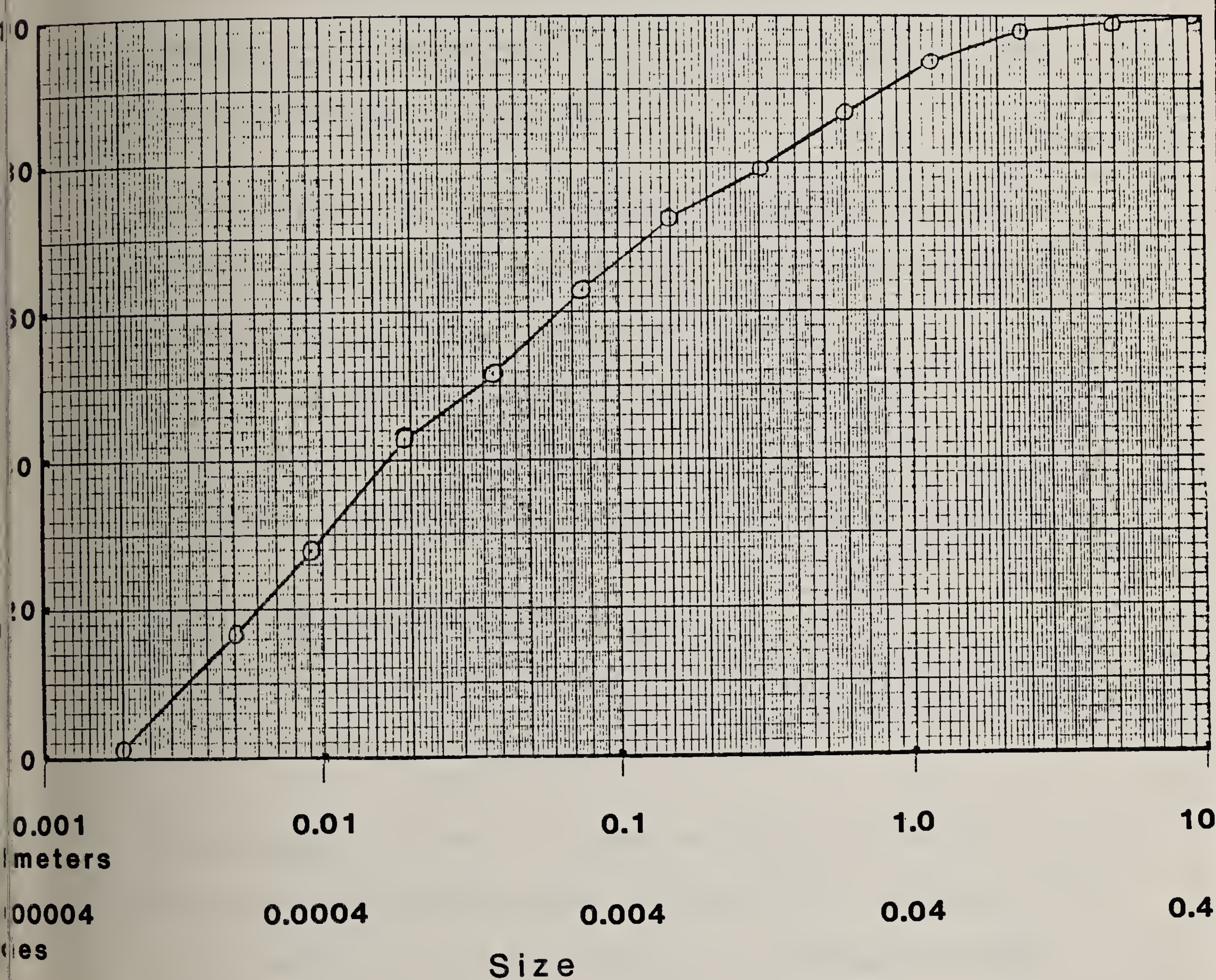


Figure 7.5
LURGI PROCESSED SHALE PARTICLE SIZE

.3 Chemical and Physical Characteristics

.3 Processed Shale Chemical Properties (Continued)

Although water conditioning processed shale will hydrate the magnesium and calcium oxides, the main effect is to enhance compaction and compression. These will be discussed under physical properties in Section 7.3.4.

Heating Value. The residual organic carbon determines the heating value of the processed shale. Assuming coke is one mole carbon combined with 0.13 mole hydrogen then:

$$\text{HV processed shale, BTU/lb} = 128 \times \text{wt\% C} \qquad (11)$$

Where wt% C = wt% organic carbon

The heating value of Lurgi retorted C-b shale was 26 BTU/lb.

.4 Processed Shale Physical Properties

The physical properties of Lurgi processed shale are related to the feed properties and process conditions.

Particle Size. Figure 7.5 shows the particle size distribution for Lurgi retorted C-b shale. Maximum size is less than 3/8 inch. Average size is about 400 mesh (0.037 mm or 0.0015 inch).

Specific Gravity. Gravity is related to the original shale gravity; it is reduced by kerogen and carbonate decomposition less the residual organic carbon remaining on the processed shale. Specific gravity for the Lurgi processed C-b shale was 2.83.

0 ROCK AND PROCESSED SHALE HANDLING AND DISPOSAL

3 Chemical and Physical Characteristics

.4 Processed Shale Physical Properties (Continued)

Bulk Density. Bulk density is related to specific gravity and void volume as previously shown by equation 6.

$$\text{Bulk Density, lb/ft}^3 = 62.4 \times \text{SpGr} \times (1-E) \qquad (13)$$

Where E = Void fraction

Lurgi processed shale had a dry bulk density of 72.6 lb/ft^3.

Compaction. Compaction increases the bulk density of processed shale allowing stable storage. Laboratory compaction tests performed on Lurgi retorted shale resulted in the following preliminary information.

Compactive Effort (ft-lb/ft^3)	Equivalent Service	Solids Density (lb/ft^3) At 10% Moisture	Solids Density (lb/ft^3) Optimum Moisture
6200	Hauling & spreading Equipment	85	85.6
12375	Highway Embankment	87	88.2
56250	Highway Subgrade	93	96.8

Compression. Unconfined compression tests determine the effects of cementing action on strength of materials cured over a period of time. All tests were run at optimum moisture content and cured at 120°F. The results for Lurgi retorted shale is:

Compactive Effort (ft-lb/ft^3)	Optimum Moisture (Wt. %)	Average Compression Strength (psi) at 0 days	at 7 days	at 14 days	at 28 days
6200	30.3	31	680	630	-
12375	28.5	40	860	930	1220
56250	23.2	362	1070	1030	-

Chemical and Physical Characteristics

.4 Processed Shale Physical Properties (Continued)

Enthalpy. Enthalpy has the same definition used to describe the heat content of raw shale in Section 7.3.2. Cameron data shows the following relationship for processed shale:

$$H \text{ processed shale, BTU/lb} = [0.174 + 5.1 \times 10^{-5} \times (t+460)]\,(t-77) \qquad (14)$$

Where t = temperature, °F

The specific heat for processed C-b Tract shale is about 0.20 BTU/lb°F.

Other Mechanical Properties. Other properties of treated processed shale will be measured to provide a complete and thorough design and proper operation. The following properties are available for Lurgi retorted shale at various compactions:

	Compaction Effort (ft-lb/ft^3)			
	None	Light (6200)	Normal (12375)	Heavy (56250)
Angle of Internal Friction, degrees				
Unwetted	29	34	32	38
Cohesion, psi				
Unwetted	21	22	33	41
Saturated	-	7.6	14	28
Moisture Permeability, Ft/yr				
50 psi loading	-	0.002	0.003	0.001
100 psi loading	-	0.003	0.005	0.001
Wind Movement Velocity, MPH				
0 Moisture	25	-	-	-
10% Moisture	-	25	-	-
Optimum Moisture	-	40	40	-

Chemical and Physical Characteristics

.4 Processed Shale Physical Properties (Continued)

Moisture permeability shows expected water permeation to be less than 1/16 inch per year. Wind tunnel results were performed for both wet and oven dried samples with the same results.

Processed Shale Placement and Compaction

.1 Introduction

As previously discussed in Section 7.3.4, the processed shale will be a dusty material ranging in sizes less than 3/8 inch with an average grain size of 400 mesh (0.037 mm). Analyses of the Lurgi processed shale classifies the material as predominately non-plastic, sand to silt sized. The processed shale will be mixed with gypsum, ash and water as shown in Table 7.1. The effect of materials added to the processed shale on compression, compaction and storage properties summarized in Section 7.3.4 is discussed below.

The processed shale created in the Lurgi process has not been as thoroughly studied as the materials produced from the Tosco II, Paraho and Union types of retorting. However, initial laboratory tests show angles of repose range from 35 to 40°, and standard Proctor Test dry densities range from 75 to 80 pcf. Once the surface retorts produce sufficient quantities of spent shale to determine the effects of the gypsum and ash addition, extensive material strength properties will be analyzed and a disposal monitoring plan will be established to ensure that the appropriate values are achieved in the field.

Processed Shale Placement and Compaction

.2 Placement and Compaction

As previously discussed in Section 7.2.4, the processed shale emerges from the surface retorting area with a moisture content from 1 to 2 weight percent, and upon mixing in the Processed Shale Treatment Building it reaches a water content of 10 percent by weight to assist compaction. Placement will consist of conveyor transport to truck load out facilities. Graders will distribute the truck dumped material into lifts for final compaction. Lift height will be determined by the specified moisture content to achieve an average density of 90 lb/ft^3. The compaction equipment employed will be selected to achieve this density consistent with the physical properties of the processed shale mixture.

The optimum moisture content in the laboratory required to achieve a particular density has no exact counterpart in the field, but does serve as a guide. Therefore, a test area shall be employed to analyze different combinations of equipment, pressure, lift thickness and moisture to determine the most desirable combinations. Moisture contents will be controlled by the addition or subtraction of water at the Processed Shale Treatment Building. Rain or snow may dictate special handling of the material at the disposal pile to achieve the proper moisture range.

Processed Shale Placement and Compaction

.3 Embankment Stability

The final configuration of the embankment side slopes will consist of 4 horizontal to 1 vertical slopes intercepted by 25 ft wide benches every 30 vertical feet. This arrangement is subject to change if full scale operation demonstrates that material properties require a more conservative geometry. Compaction will be critical at the outer zones of the embankment, and greater densities will be maintained in these areas to achieve a static factor of slope safety of 1.5 or greater. The final design of the embankment will quantitatively address this subject. The potential for liquefaction under dynamic loadings will also be addressed, although the saturation necessary for such a condition is not likely due to the climate of the area and high evapo-transpiration rates.

The information collected during the early stages of embankment construction will be employed to assure the final outslope geometry is stable under all reasonable loading conditions. Specifically, the effects of the gypsum and ash addition on the geotechnical properties of the material will be investigated and used to ensure an environmentally sound final design.

ACCESS AND SERVICE PLANS

General Corridor Development Planning

The development of the tract for a commercial shale oil project will require the transportation of personnel, material, products and services to and from the tract from a variety of geographic locations. This Corridor Plan was developed with the objectives of minimizing environmental harm and generally providing sound planning for off-site activity. These objectives are best met by the use of multiple-purpose corridors when feasible. In addition to the plans set forth here, the Lessee has prepared other plans which deal with both access and service corridor plans. These various plans are discussed as indicated.

- Water Pollution Control (Section 9.2)
- Oil and Hazardous Materials Spill Contingency Plan (Section 9.3)
- Protection of Objects of Historic and Scientific Interest and Aesthetic Values (Section 9.6)
- Fish and Wildlife Management Plant (Section 9.9)
- Erosion Control and Surface Rehabilitation Plan (Section 9.10)

.1 Development Activities

In connection with the early development (1974-1980) of the tract, the Lessee built a road to the tract for personnel, equipment and materials. Early activities also included the construction of a natural gas pipeline, telephone communication line and microwave and electrical power supply facilities to the tract. Through 1981, all access and utility development has

General Corridor Development Planning

.1 Development Activities (Continued)

been accomplished utilizing local Piceance Creek facilities to the tract. In 1980, substations near Meeker, Colorado and an on-tract switchyard were under construction. A 138 kv power line is scheduled for construction in 1981 to tie the above facilities to Tract C-b for electrical power which will be necessary for initial development.

.2 Proposed Activities

Future construction work will include the building of water and shale oil product pipelines. The use of unit trains may comprise a possible alternative to pipelining. Construction of a rail line into the Piceance Basin is a longer term activity, which will require the support of other oil shale and mineral developers. Ammonia will be produced (see section 5.2.6) and transported by tank trucks to a railsiding at Rifle for shipment via railroad tank cars.

C-b Tract Utility and Fuel Plans

A four-inch natural gas line to the mine development area supplies natural gas to an electric generating plant consisting of nine 1,000 KW diesel conversion engine driven generators, with space for an additional generator. The generator plant is presently supplying the electrical power for shaft sinking, mine water pumping, and miscellaneous power and lighting requirements.

C-b Tract Utility and Fuel Plans

The first stage of an electrical power supply system for the project is presently under construction by the White River Electric Association, Inc. This consists of a single 138,000 volt transmission line from Meeker to the project where it will connect to a 30,000 KVA transformer in a substation at the mine support area. This will supply power to the 13,800 volt distribution system for the mine. It is expected that this system will be in service in the fall of 1981. At that time the power will be needed for testing and startup fo the main hoists. The diesel engine generator plant will be converted to emergency service at that time.

Stage II of the power supply system, consisting of an additional 138,000 volt transmission line paralleling the initial 138 kv facility and 30,000 KVA transformer will be installed during 1983-84. At that point, the off-site natural gas supply will be used as fuel for standby power generation, mine air heating, as well as general space heating.

Stage III of the power supply system will add a 30,000 KVA transformer at the process substation to supply power during the startup phase of the process plant (1986-87). During this period, an electric generation plant and a process steam plant will be constructed. They will operate on process off-gas as fuel. Natural gas will be used only to generate steam for process startup. As process off-gas becomes available, use of natural gas will be phased out.

C-b Tract Utility and Fuel Plans

Stage IV of the power supply system, which will consist of a fourth 30,000 KVA transformer and additional switchgear, will be constructed along with the power generation plant (1988-89). As the mine becomes fully operational, it is expected that the project will be able to supply its entire energy needs from the off-gas, with excess power available for export to the power supply system.

Power consumption estimates are based on the following assumptions:

.1 MIS Power Consumption

A. Fluor Case VI power consumption was used for all trains coming on line except the first. For the first train, it was assumed that 50% of the MIS gas blowers were electrically driven.

B. All electrical demands are for process equipment. The demand reflects an actual, gross electrical power usage.

C. Power consumption for each train increased linearly with startup period. The startup period for each plant is the time between mechanical completion and the date the next train became mechanically complete. The last SPF train had a startup time of one year.

D. Final SPF power consumption assumes that the first train (electrically driven blowers) is the "spare" train.

.2 AGR Power Consumption

A. Estimates provided by Lurgi were used to define the AGR power requirements.

B. The schedule of Chapter 3 was used for AGR development.

C. The power is an actual, gross requirement and reflects all electric power consumed by the AGR units.

D. The power consumption for each unit increased linearly over its startup period. The startup period for each train was defined as the period between mechanical completion and the succeeding train startup. The last AGR had a one year startup.

C-b Tract Utility and Fuel Plans

.3 Mine Power Consumption

A. The rock haulage schedule from Chapter 3 was used to reflect mine operations.

B. To relate mined rock rates to power, a constant factor of 0.6025 MW per 10^3 TPD was used.

Time phasing of on-tract power supply and power consumption is summarized on Table 8.1, along with net power import/export.

Off-site Receiving and Shipping Facilities

An undeveloped 40-acre staging facility has been procured about 2 miles east of Rifle adjacent to the D&RGW railway line. A rail spur from the existing Denver and Rio Grande Western Railway main line will be laid to the staging facility. This spur will disturb approximately five to ten additional acres. During the construction phase, materials, vessels and equipment will be stored at the staging area and will be trucked to the tract via State Highway 13/789 and the Piceance Creek Road. Later, the staging area will function as a terminal for shipment of ammonia and shale oil by rail, and to receive cement, limestone, ammonium nitrate and operating supplies shipped by rail.

By-product storage will be provided at the product shipping terminal. High-pressure vessels (bullets) for ammonia will be located at the terminal facilities. All high-pressure storage vessels will contain a relief valve. Each of the vessels will be surrounded by a system of water sprays or foam system providing complete coverage. The water sprays will be automatically triggered in the event of a fire.

TABLE 8.1 Power Consumption/Generation at CB versus Year

POWER CONSUMED, (MW)

MINE	AGR	SPF	MISC.	CONSUMPTION	GENERATION (MW)	IMPORT/(EXPORT)
0.36	0	0	4.0	4.36	0	4.36
2.4	0	0	6.0	8.24	0	8.4
7.8	0	0	5.2	13.0	0	13.0
14.5	0.8	0	4.9	20.2	0	20.2
19.9	1.6	7.0	5.0	33.5	(4.2)	29.3
25.6	2.4	20.0	6.0	54.0	(16)	38.0
34.0	6.8	26.0	6.7	73.5	(69)	4.5
34.6	10.4	33.5	8.0	86.5	(114)	(27.5)
34.6	11.2	47.5	9.7	103.0	(164)	(61)
37.7	11.2	52.0	11.7	112.6	(227.7)	(115.1)
37.7	11.2	47.3	11.7	107.9	(226.7)	(119.8)

* Dist. losses, offsites, generation (step-up) losses.

1) AGR, SPF power figures from Fluor Case VI-A, October, 1980

2) Mine power figures from PSD rock haulage schedule, and using 0.6025 MW per 10^3 TPD.

ACCESS AND SERVICE PLANS

Off-site Receiving and Shipping Facilities

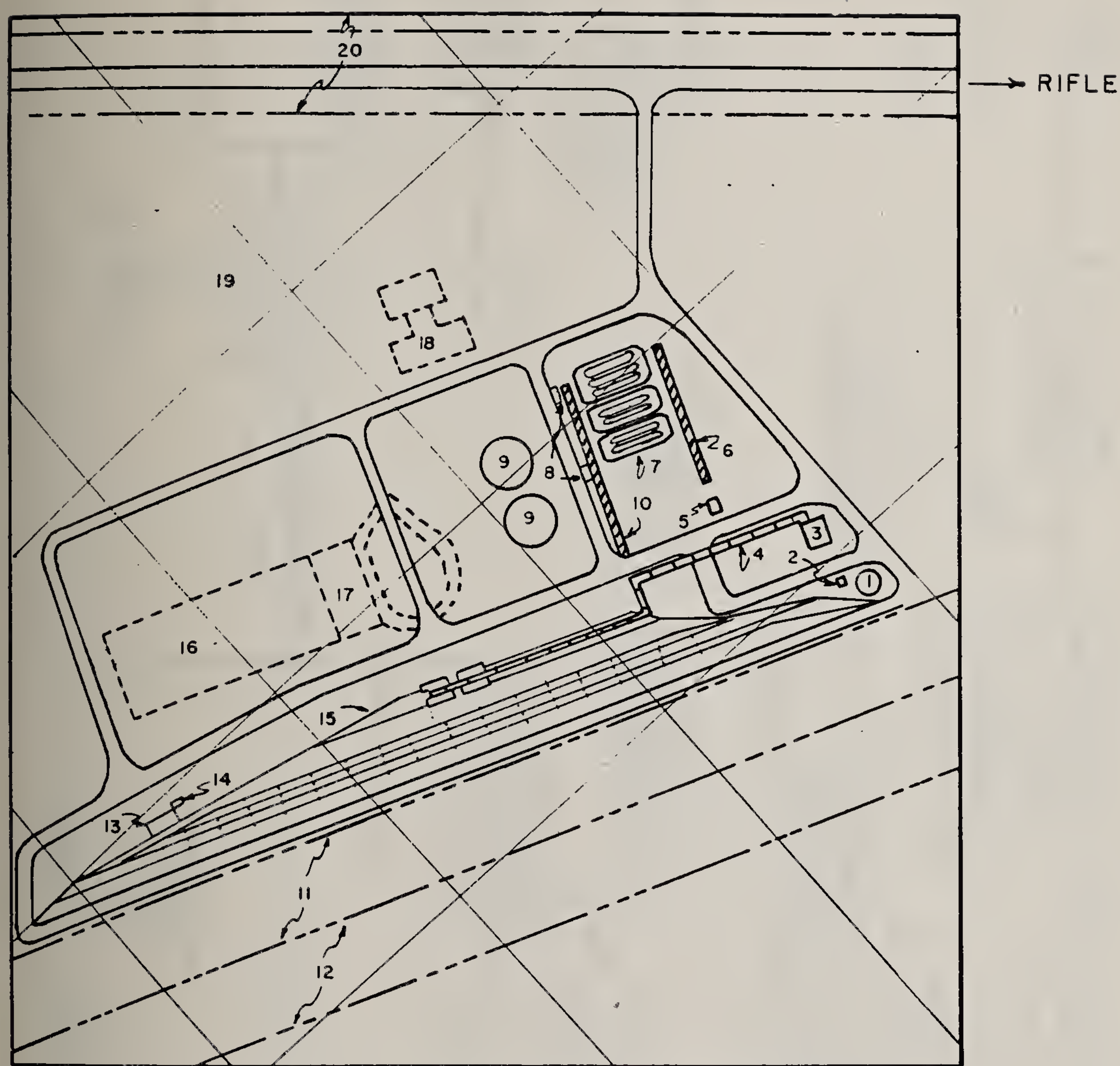
The entire storage complex will be interlocked to a system of local shutdown stations which will, upon activation, cause all operations to cease in the event of a malfunction.

The railroad trackage leading to and within the terminal area will be of standard design conforming to American Railroad Engineering Association standards. Within the staging area, a conventional track system will be constructed so the railroad will be able to make scheduled deliveries and pickups. A loading dock and weigh station for rail and truck traffic will also be installed. Figure 8.1 shows plans for the Rifle terminal and staging area.

Overall Water Management Plan

.1 Water Balance

A most likely process scheme for overall water management is presented on Figure 8.2. The plan presented describes overall water use for steady-state operation at full production. Engineering evaluation is proceeding to optimize water treatment and reutilization processes to make most effective use of recovered condensates and retort water. The plan outlined on Figure 8.2, and the resultant water balance on Table 8.2 represent the current state of engineering design for efficient water management.



1. FIRE WATER STORAGE 2. FIRE WATER PUMPHOUSE 3. UTILITY BUILDING 4. PIPEWAY 5. CONTROL VALVES 6. SLEEPERWAY 7. AMMONIA 8. PUMPS 9. SHALE OIL STORAGE TANKS 10. SLEEPERWAY 11. 150' WIDE RAILROAD R/W 12. ROAD R/W 13. SCALE TRACK 14. SCALE HOUSE 15. LOADING TRACKS 16. MODULAR SHOP 17. WAREHOUSE 18. CONSTRUCTION OFFICES 19. LAYDOWN AREA 20. ROAD R/W

NOTE: FACILITIES SHOWN DASHED ARE TEMPORARY ONLY. THEY WILL BE REMOVED AFTER CONSTRUCTION IS COMPLETE. FACILITIES SHOWN SOLID ARE PERMANENT.

Figure 8.1

RIFLE TERMINAL AND STAGING AREA

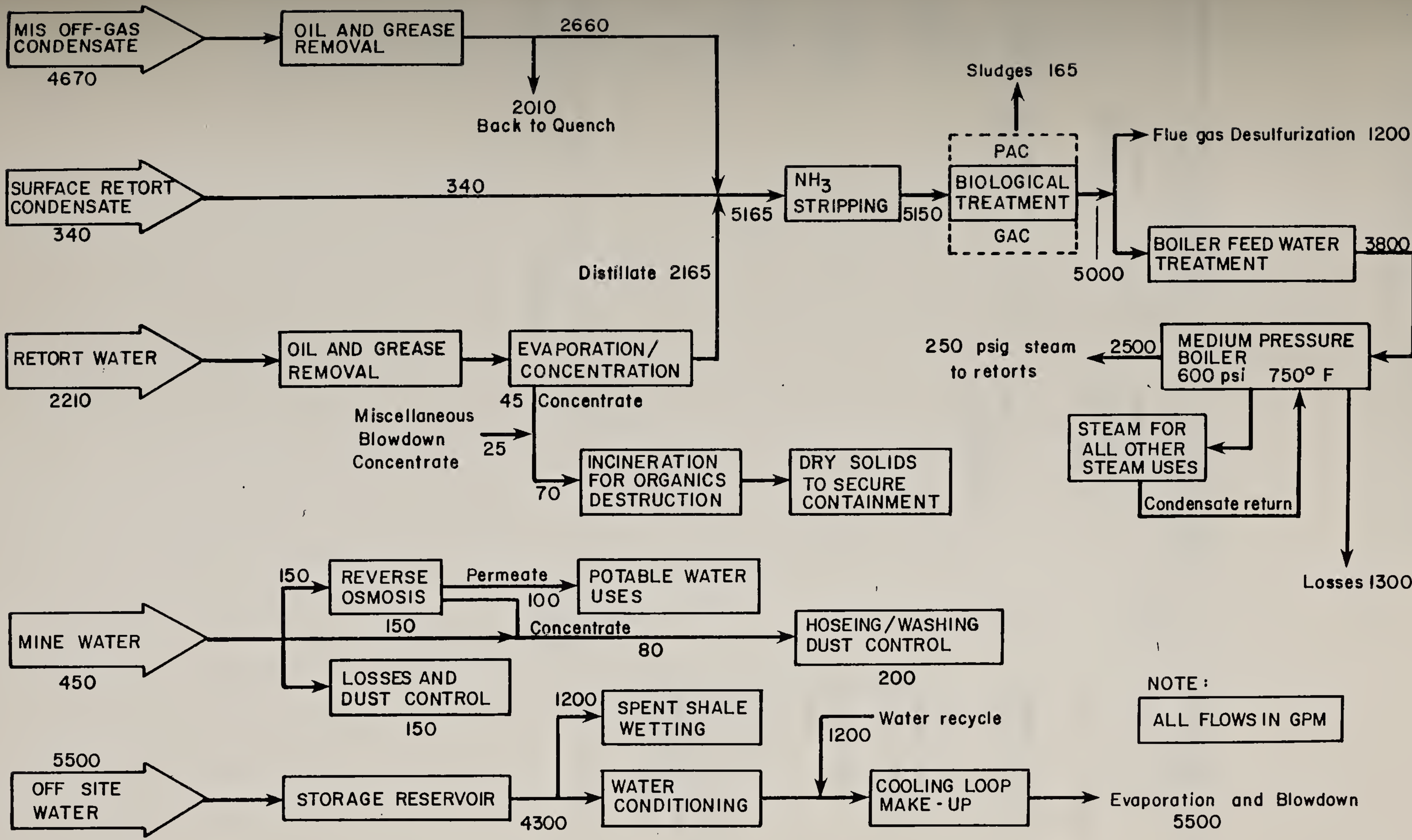


FIGURE 8.2
OVERALL WATER MANAGEMENT PLAN

TABLE 8.2 Water Supply and Water Use for the Cathedral Bluffs Shale Oil Project (gpm)

pply		To Recycle		From Cycle		Consumption Use	
as e		To Quench Retorts	2,101	Recycle to Cooling Makeup	1,200	FDG Sludge	1,200
						Misc. Sludges	235
etort e	340	To Retort Steam	2,500			Steam Losses	1,300
				Misc. Blowdown	25	Potable Water	100
ter	2,210					Losses and Dust Control	350
t	450					Processed Shale Wetting	1,200
eWater	5,500					Cooling Tower Evaporation and Blowdown	5,500
al	13,170		4,500		1,225		9,885

Overall Water Management Plan

.1 Water Balance (Continued)

Water Supply. The surces of supply are discussed earlier in Section 5.2.5. In total, these are in the range of 13,170 gpm inclusive of off-site importation.

.2 Water Use

Water use requirements will vary seasonally, owing primarily to increased evaporative cooling losses under summer conditions.

Evaporative Cooling. The largest single use of water at C-b will be 5,500 gpm evaporation and blowdown makeup for fin-fan coolers on the MIS off-gas, and combined evaporation and drift from a general service cooling tower which serves the surface retorting facilities, and miscellaneous heat loads.

Steam Losses. Miscellaneous steam and condensate losses to the atmosphere are estimated at 1,300 gpm. Efforts will be extended through maintenance and plant practices to reduce nonessential, nonprocess losses.

Flue Gas Desulfurization. Makeup requirements for the flue gas desulfurization (FGD) system are expected to be about 1,200 gpm. The feed water quality specifications for the FGD units are such that wastewaters from other surface processing components can be consumptively utilized. The contaminated water input becomes tied up for the most part with the calcium sulfate sludge, and is disposed of in accordance with appropriate control procedures (Section 9.2).

Overall Water Management Plan

.2 Water Use (Continued)

Retort Steam. The steam requirement for moderating the in-situ combustion process is estimated at 2,500 gpm. Current plans are to utilize treated condensates and retort water to generate the required steam.

Shale Moisturizing. Processed shale from surface retorting operations will require spraying for cooling and dust control. Approximately 1,200 gpm of water of varying quality will be used in processed shale handling.

Miscellaneous Uses. Miscellaneous requirements include dust control sprays, potable water use, fire protection, boiler feed makeup, and miscellaneous utility streams.

.3 Water Management Strategy

Zero Discharge. The water management plan is based on zero discharge of liquid effluents in order to conserve the regional water resources and to minimize the effects of the project on the surrounding area. From Table 8.2, it is evident that plant water needs will exceed the available on-site supply of treated mine water and process-generated wastewaters, requiring off-site water to be brought in as a supplement.

Distribution. The method of allocating water has been to compare the characteristics of the available sources with the requirements

Overall Water Management Plan

.3 Water Management Strategy (Continued)

for the various uses, and to route water where it can be used satisfactorily with the least treatment.

Two other criteria are the dependability of the water source and the timing of the water need. Off-site water, the most dependable supply, is the primary source for boiler feedwater. Potable water, needed before process startup, will be provided from alluvial wells located on or adjacent to the tract.

.4 Mine Water

Early Excess. Although present information points to the need for an off-site water suplement to reach full production, mine dewatering operations will produce more water than is required for on-site use through 1986.

Disposal of Excess. Disposal of excess mine water in the early years of commercial development involves treatment to control pH and other parameters as required by permit conditions, and subsequent discharge to Piceance Creek. Sprinkler irrigation is used to handle excess flows during summer. Reinjection wells will be utilized for disposal of up to 1280 gpm back in the water bearing strata.

As an economy measure, commencing September 2, 1981, the V/E shaft has been allowed to fill with water under an interim

Overall Water Management Plan

.4 Mine Water (Continued)

operation plan approved by the OSO. As depicted on the mine development schedule (Figure 3.2), the V/E shaft will then be dewatered commencing in January 1983 with recovery and equippng completion expected by July 1983. This action has no detrimental effect on the overall project development schedule. Economic benefits accrue from the fact that 1) funds that would have been used for nonproductive shaft operation and water handling are used for project construction and 2) there is conservation of water in place with less negative impact on groundwater levels north and west of the tract.

.5 Water Supply Augmentation

Based on hydrologic studies conducted to date, mine drainage water will be available initially in excess of project needs. At full production, net water use will exceed on-site sources of supply, requiring that water be imported (see Table 8.2). Additionally, streamflow depletions and reduction in aquifer levels might be expected as a result of extensive mine dewatering. Studies are underway to quantify the expected depletions.

Augmentation Planning. Under the doctrine of prior apopropriation, Colorado water law requires that depletions which accrue to holders of senior water rights be augmented. In order to deal with the need for off-site water, and streamflow and groundwater

Overall Water Management Plan

.5 Water Supply Augmentation (Continued)

depletions, a water use and augmentation plan has been outlined for the Disctrict Court having jurisdiction over the Project area. The plan was formulated in 1977 and will be updated for the Court in 1981 to include the results of further investigation into the relationship of the upper and lower aquifer systems, the effects of development mining, and probable impact of commercial operations on streamflow and holders of senior water rights.

The essential element of the plan is a requirement for compensation of persons whose rights to beneficial use of water in priority are in fact adversely affected due to mining and retorting oeprations in Tract C-b. The plan provides for replacement of water from one or more of the following sources:

1. White River-Piceance Creek Pipeline;
2. Powell Park Reservoir;
3. Such other sources as Tract C-b Lessees are able to secure judicial approval for use in augmentation.

The Lessees hold conditional decrees having an August 5, 1966 appropriation date for the White River-Piceance Creek Pipeline, and Powell Park Reservoir. Approximate locations for the pipeline route and reservoir site are shown on Figure 8.3.

Overall Water Management Plan

.5 Water Supply Augmentation (Continued)

Off-Site Supply. Initial off-site water will be derived from reservoir storage on Willow Creek Reservoir No. 1, Hunter Creek-Willow Creek Pipeline, and Willow Creek Tract C-b Pipeline as shown on Figure 8.4. Pursuant to an application filed with the District Court for Water Division No. 5, Willow Creek Reservoir No. 1 will be an on-channel reservoir, with a storage capacity of 6,000 acre-feet. The approximate 12,500 foot Hunter Creek-Willow Creek Pipeline (capacity 6 cfs) will convey water from Hunter Creek to the reservoir. Other sources of water for the reservoir will include flow in Willow Creek, excess mine water from Tract C-b, and the White River via the White River-Piceance Creek Pipeline. The reservoir will thus serve as a source of interim storage prior to use on C-b. Delivery to the tract will be via Willow Creek-Tract C-b Pipeline.

The long-term source for off-site water will be the White River. Conditional water rights having an appropriation date of August 5, 1966 feature a direct flow right from the White River in the amount of 100 cfs for the White River-Piceance Creek Pipeline, and a storage right in the amount of 75,970 acre-feet for the Powell Park Reservoir (Figure 8.3).

The CB venture is also exploring the possibility for a joint industry-State-Federal reservoir, diversion facilities, and

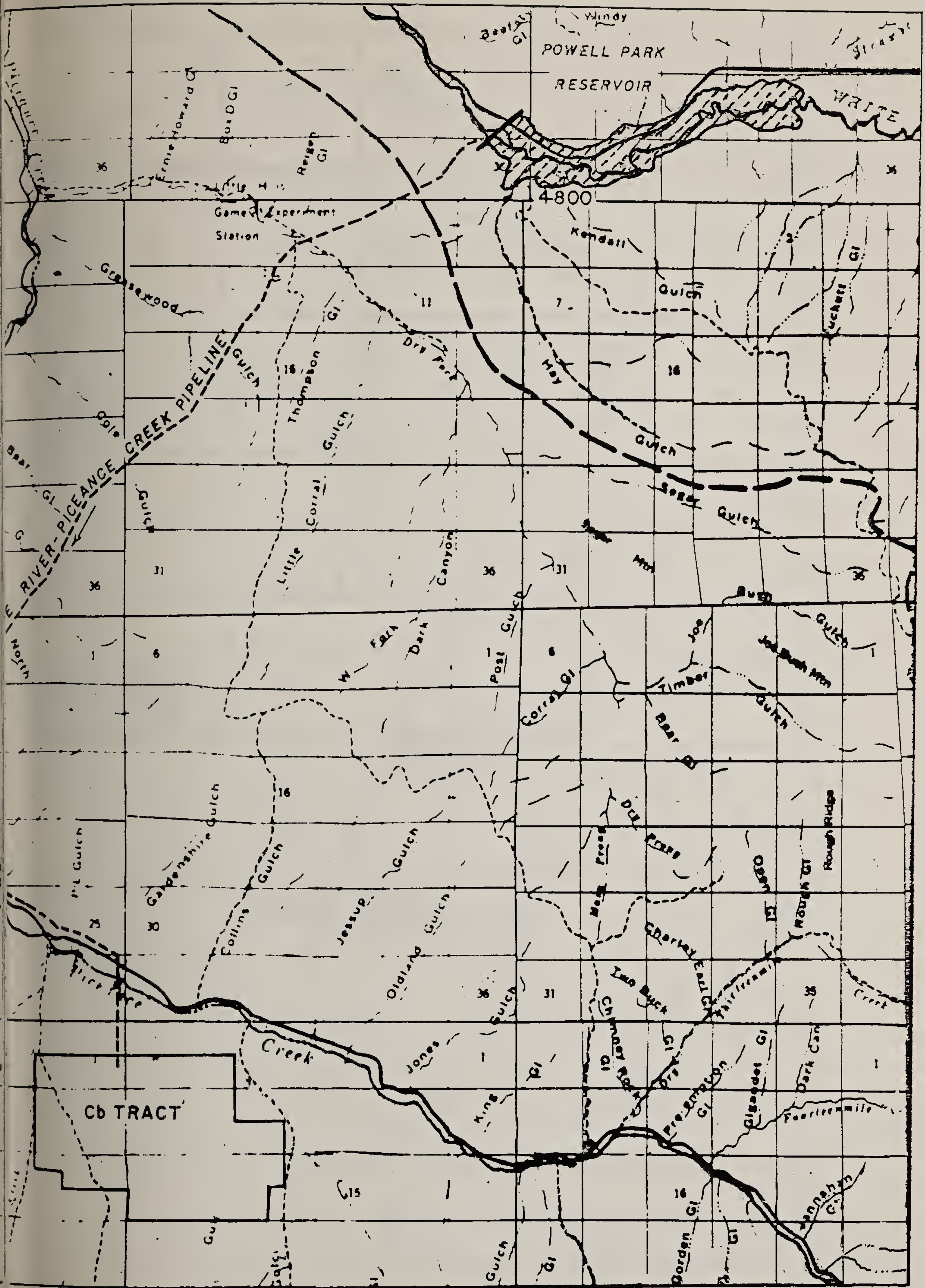


Fig. 8.3
PICEANCE CREEK PIPELINE
&
POWELL PARK RESERVOIR

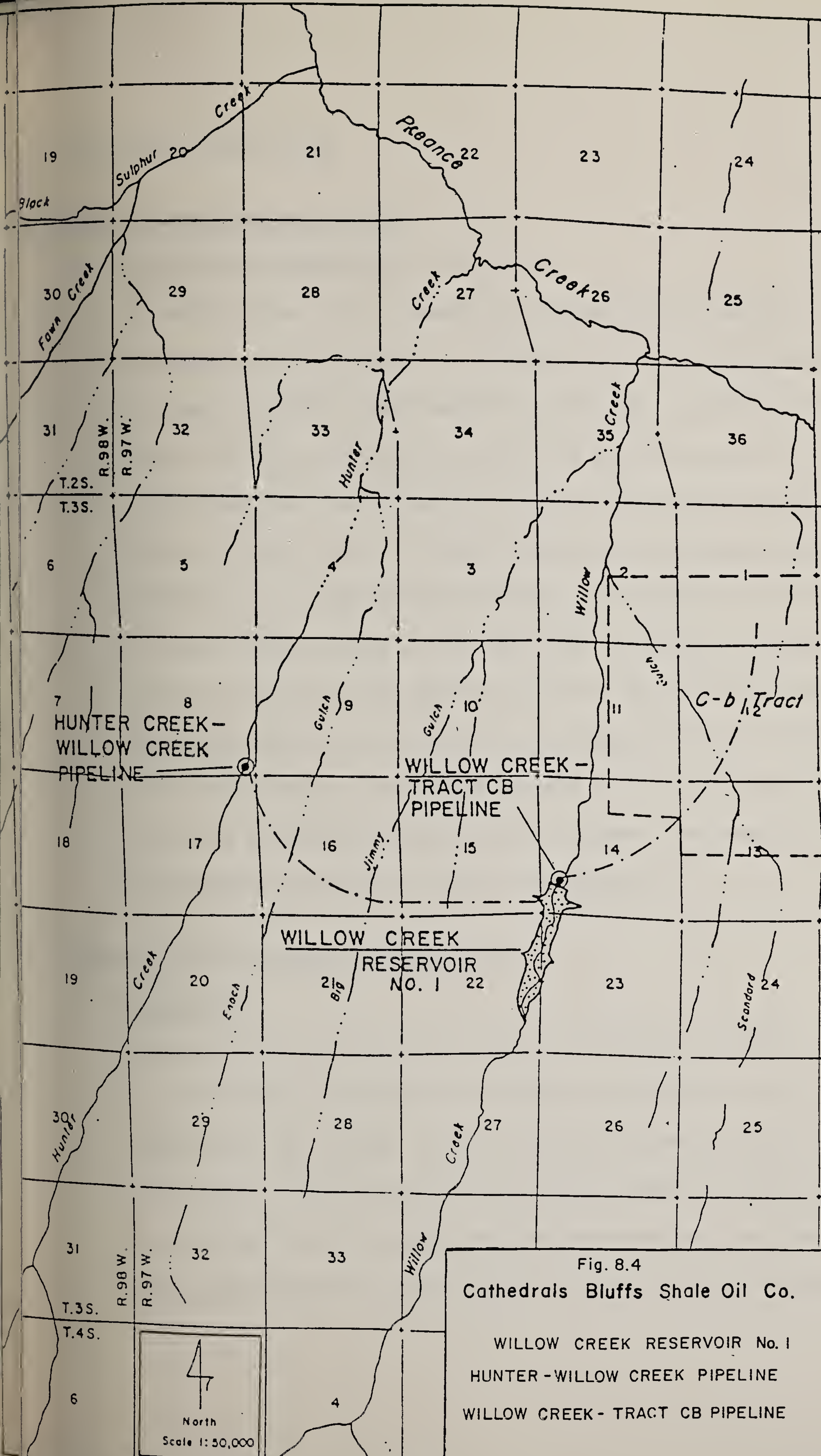


Fig. 8.4
Cathedrals Bluffs Shale Oil Co.

WILLOW CREEK RESERVOIR No. 1
HUNTER-WILLOW CREEK PIPELINE
WILLOW CREEK-TRACT CB PIPELINE

4 Overall Water Management Plan

.5 Water Supply Augmentation (Continued)

delivery system. This concept offers substantial economic advantages (capital cost of stand-alone faciltiy is estimated at 2.3 times greater; annual operating costs are about 4 times the annual cost per acre-foot of yield from a joint project). It is also attractive from the point of view of more efficient utilization of water rights. A joint project can be designed and located so as to enhance recreational and fisheries use of the affected streams, while at the same time minimizing pumping costs and maximizing the quantity of water which can be relied upon for industrial, agricultural, and municipal use. Efforts will continue toward organizing support for such a project and developing preliminary engineering to support the necessary environmental studies and permit applications.

5 Shale Oil Marketing and Transportation

.1 Production

Production plans for the CB venture are outlined in Table 8.3. The data are inclusive of naphtha production, which is blended with the product to help alleviate potential pipelining difficulties. The majority of production (60%) will come from the modified in-situ process and the remainder will be from above ground retorting (Lurgi) (40% of the in-situ mined material).

Shale Oil Marketing and Transportation

.1 Production (Continued)

TABLE 8.3 Cathedral Bluffs Production Plan

	MIS*	AGR**	(MMB/YR) Total	(MBPCD)***	(MBPSD)****
				Total	
1984	0.50	0.70	1.20	3.6	4.5
1985	2.85	1.76	4.61	13.8	17.2
1986	4.53	2.46	6.99	20.7	26.6
1987	5.37	2.81	8.19	24.5	30.6
1988	9.57	6.91	16.48	49.3	61.6
1989	13.43	10.88	24.31	72.7	90.9
1990	19.80	11.23	30.04	89.8	112.3
1991	20.14	11.23	31.37	93.8	117.3

*Modified In-Situ

**Above-Ground

***Thousand bbl/calendar day

****Thousand bbl/stream day

.2 Market Outlook

Shale oil can be refined to produce essentially all fuels produced from conventional petroleum.

Use of whole shale oil as a boiler fuel may be an interim outlet during the early years when production is limited and on an intermittent basis. Due to the exemption from the Utility and Industrial Fuel Use Act, which restricts the use of natural

Shale Oil Marketing and Transportation

.2 Market Outlook (Continued)

gas or oil as a boiler fuel if in a mixture with an alternate fuel such as shale oil, those installations facing an expensive converison may find shale oil use attractive where it can be burned directely or blended with other fuel oils without excessive emissions of nitrogen oxides and/or particulates.

The natural properities of raw shale oil will require some type of on-site pretreatment to improve pumpability, and potentially to remove contaminants which might hinder conventional refinery processes. By comparison with ordinary petroleum crude, raw shale oil is a viscous, medium gravity oil with high pour point, high olefins content, moderate sulfur and high nitrogen and oxygen contents. Shale oil also contains relatively higher concentrations of metals, i.e. Fe, As, etc., which are poisonous for certain refining catalysts. These properties vary according to the retorting process used.

Studies are under way to characterize the C-b product, and to define necessary pre-treatment (e.g., addition of pour point depressants) to enhance pumpability of the material. More rigorous measures such as on-site upgrading are not featured in current plans for development, but are being examined as alternatives for improving overall marketability of the shale oil product (Section 11.6).

Shale Oil Marketing and Transportation

.3 Transportation Planning

Owing to the gradual production buildup as depicted in Table 8.3, product transportation will initially involve truck transport and small pipeline to unit train operation, eventually leading to construction of a common carrier pipeline. Truck transport will feature 8-10,000 gallon capacity transports to the vicintiy of a rail siding near Rifle for transfer to unit tank cars. Preliminary studies have also been made for the Colorado West Area council of Governments on a Rifle-Meeker-Piceance Basin rail route.

Subsequently, a 4-6 inch pipeline will be constructed along an as-yet-to-be-identified corridor, and which will merge with rail loadout facilities in or near Rifle. This line will be capable of moving some 5,000-15,000 barrels per day, and will serve through early 1987, at which time it is intended that a common carrier-type pipeline will be available. The smaller pipeline will then be refitted and utilized in transporting diesel fuel to the tract.

Common carrier pipeline construction, including ownership and operation, are matters which will receive additional study. As presently structured, such construction is beyond the scope of the Cathedral Bluffs partnership. In turn, both Tenneco and Occidental are free to pursue an equity position in a pipeline. The range of options available extends to participation in a

Shale Oil Marketing and Transportation

.3 Transportation Planning

regional delivery system which might handle the combined output of a Piceance Basin oil shale industry.

.4 Existing Pipeline Systems

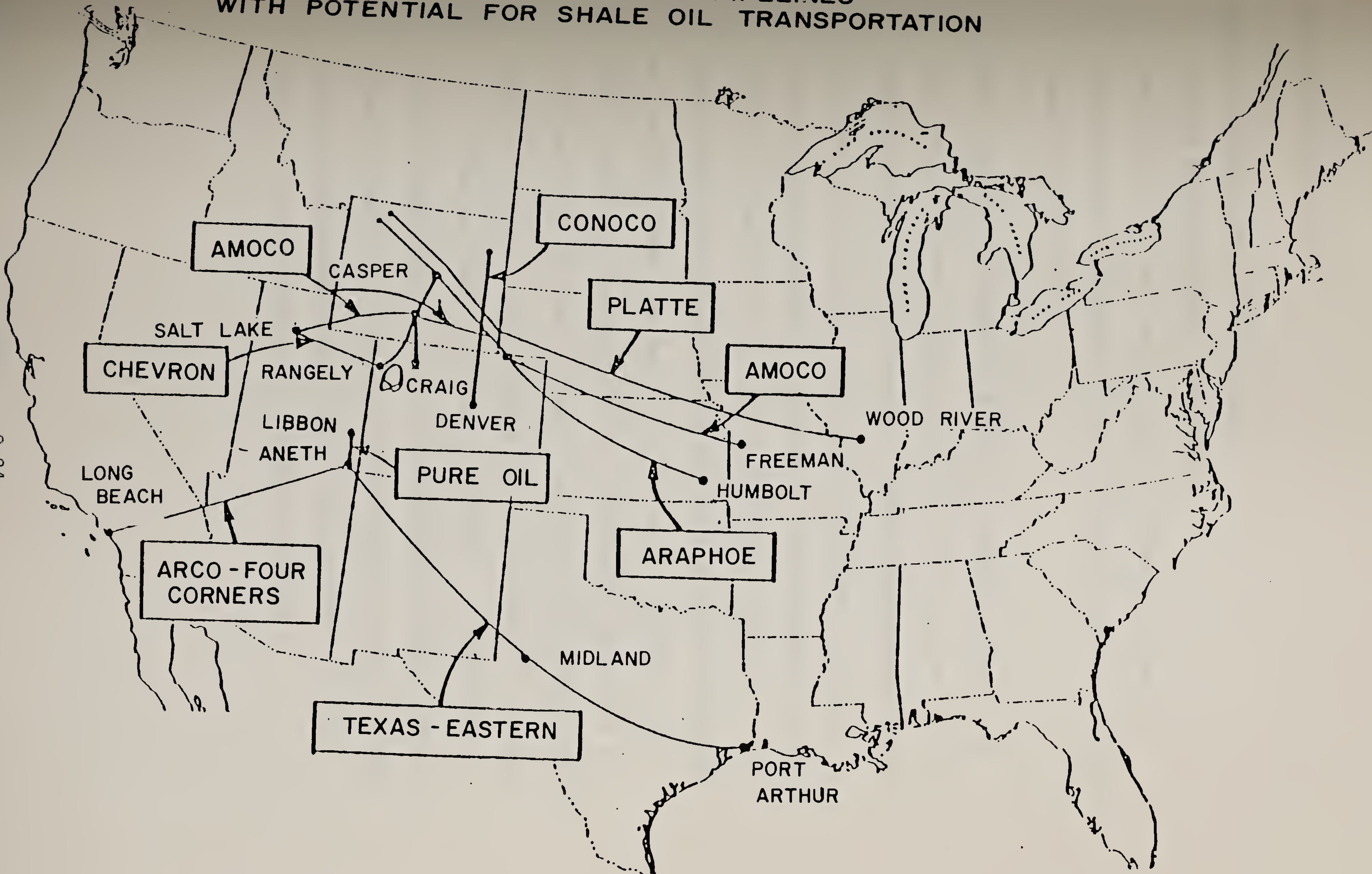
Two existing crude oil pipeline systems have the potential to transport raw or upgraded shale oil. The northern system and the southern system are shown in Figure 8.5. The ability of both systems to handle projected shale oil production is dependent on conventional oil production levels and the distribution scheme for Alaskan North Slope oil in the area. Both systems would require construction of connecting lines to connect with Piceance Creek oil shale facilities and expansions to increase available capacity. A description of the two existing crude oil pipeline systems follows.

Northern System. The northern system was developed to move crude oil from the states of Montana, Wyoming, Colorado, and Utah to refineries located in those states, and to export crude oil production in excess of refining capacity.

Chevron Oil Company operates a crude oil pipeline that originates at Rangley, Colorado and terminates at Salt Lake City, Utah. The line consists of two 10-inch pipelines, each 160 miles long with a capacity of 105 thousand barrels per day and a throughput of 100 thousand barrels per day. Although existing available

FIGURE 8.5

EXISTING CRUDE OIL PIPELINES WITH POTENTIAL FOR SHALE OIL TRANSPORTATION



Shale Oil Marketing and Transportation

.4 Existing Pipeline Systems (Continued)

capacity is relatively small, declining domestic crude oil production and/or expansion of the line could increase available capacity significantly.

Amoco pipelines originate at Rangley, Colorado (10-inch) and near Craig, Colorado (8-inch). The 10-inch line connects with another 8-inch line which crosses southern Wyoming and connects Salt Lake City, Utah with Fort Laramie, Wyoming. The Fort Laramie terminus includes a connection with the major 20-inch Amoco line from Elk Basin, Wyoming to Freeman, Missouri. The 8-inch line from Craig, Colorado crosses the southern Amoco line and terminates near the Amoco line in Casper, Wyoming. The Amoco line across southern Wyoming is operating at capcity to Salt Lake City (40 thousand barrels per day), and slightly below capacity to Fort Laramie, Wyoming (29 thousand barrels per day with 25 thousand barrels per day throughput). If this Amoco system in Wyoming and Colorado were expanded to handle large volumes of shale oil, it would provide access to several other pipeline systems which supply both major and minor refining centers. Possible tie-ins are listed in Table 8.4.

Shale Oil Marketing and Transportation

.4 Existing Pipeline Systems (Continued)

TABLE 8.4 Potential Shale Oil Pipeline Ties

Pipeline	Terminals	Excess Capacity (BPD)
Amoco (20-inch)	Elk Basin, Wyoming to Freeman, Missouri	45,000
Platte	Byron, Wyoming to Wood River, Illinois	120,000
Conoco	Gurnsey, Wyoming to Denver, Colorado	18,000
Arapahoe	Gurley, North Dakota to Humboldt, Kansas	100,000
	Total	283,000

Source: "Overview of Shale Oil Development and Utilization," Pace Company Consultants and Engineers, Inc., November, 1980

Once the shale oil reaches the Midwest via the Amoco, Platte, or Arapahoe pipelines, other pipeline connections could transport the shale oil to refineries in the region having the available processing facilities.

As noted, many of these alternatives may be affected by potential flow of Alaskan North Slope crude oil from the proposed Northern Tier pipeline. However, shale oil could supply the secondary market or southern markets of the proposed Northern Tier pipeline with about 280 thousand barrels per day through existing pipeline systems. In addition, the Amoco system allows access to the refineries in Utah, Wyoming, and Montana which are

[illegible]

[illegible]

[illegible]

[illegible]

Shale Oil Marketing and Transportation

.4 Existing Pipeline Systems (Continued)

currently running below capacity because of curtailment of Canadian imports and declining local production.

Southern System. The southern system (see Figure 8.5) was developed to move crude oil from the Four Corners area to Long Beach, California and the Midland, Texas area. However, the western stretch from Long Beach to the Four Corners area is currently moving 28 thousand barrels per day of Alaskan North Slope crude oil from Long Beach to the Four Corners area. Due to the surplus of Alaskan North Slope crude oil on the West Coast, movement of shale oil in this system would be more logically to West Texas or the Gulf Coast.

The Pure Oil Pipeline originates in Lisbon, Utah and terminates at Aneth, Utah. The rated capacity is 50 thousand barrels per day and throughput is 35 thousand barrels per day. Construction of pipelines from the Piceance Creek basin to Lisbon, Utah and expansion of the Pure Oil Pipeline would allow shale oil to be transported to the south, where it could enter the Texas-Eastern pipeline.

The Texas-Eastern pipeline orginates at Aneth, Utah and terminates at Port Arthur, Texas. The line has a capacity of 100 thousand barrels per day and throughput of 80 thousand barrels per day. Expansion of this line would allow transportation of significant

[illegible]

[illegible]

[illegible]

[illegible]

Shale Oil Marketing and Transportation

.4 Existing Pipeline Systems (Continued)

volumes of shale oil from the Pure Oil Pipeline at Aneth to West Texas and the Gulf Coast. However increased deliveries of Alaskan North Slope crude oil by way of the Arco Four Corners pipeline would decrease capacity available for shale oil.

It appears that existing crude oil pipeline systems have the potential to move about 300 thousand barrels per day of shale oil to the Gulf Coast and Midwestern refining centers. Utilization of this excess capacity will require major expansion or new construction of feeder lines from the oil shale region to the Platte, Amoco, and Arapahoe lines to the north, and the Texas-Eastern line to the south. Utilization of this available capacity is also dependent on the rate of decline of local conventional crude oil production and shipments of Alaskan North Slope crude oil from the proposed Northern Tier pipeline. Once shale oil production reaches 300 thousand barrels per day, major new pipelines will be required to handle any additional production.

However, in the short term, existing lines which originate in the shale oil region appear wholly adequate to handle shale oil production levels in excess of 50 thousand barrels per day.

.5 New Shale Oil Pipelines

While no specific proposals can be identified at this time, a number of potential options are open to CB. One of these

Shale Oil Marketing and Transportation

.5 New Shale Oil Pipelines (Continued)

involves possible participation in a Piceance Basin oil shale pipeline. The sizing and routing of such a facility are matters which will receive additional study as oil shale development progresses toward full-scale commercialization.

By-Product Marketing and Transportation

.1 Ammonia

As discussed at Section 5.2.6, approximately 285 tons per day of high-quality fertilizer grade anhydrous ammonia are recovered from MIS offgas. Tank trucks would be used for transport to a Rifle railsiding for trans-shipment via railroad tank cars.

.2 Electric Power

Excess electric power in the amount of as much as 100 megawatts may be available for sale off-site. Utility systems studies are ongoing which will lead to the design of transformers and switching devices to facilitiate the interchange of incoming and outgoing power over the 138 kv interite with White River Electric Cooperative.

No estimates are available concerning the possible distribution and utilization of excess electric power. Such information will become available as design of the project proceeds, and agreements entered with appropriate regional generation and transmission entites.

By-Product Marketing and Transportation

.3 Other Materials

The only other by-product material anticipated under the current process design, and which may have commercial significance is the large quantity of processed shale from the surface retorting units. Preliminary studes suggest that the Lurgi-retorted shales share many of the same characteristics of Portland cement. The potential for beneficial use of what amounts to a very large volume waste product will be evaluated further.

ENVIRONMENTAL CONTROL PLANS

Air Quality Control Plan

.1 Activities and Processes Affecting Air Quality

Those activites and processes affecting air quality include:

1) Raw shale storage stockpile and handling,

2) MIS offgas scrubbing and compression,

3) ammonia stripping and recovery,

4) MIS boilers and flue gas desulfurization,

5) above-ground retorting,

6) processed shale handling and disposal, and

7) general arrangement of surface facilities.

These activities have been discussed in detail in previous chapters. For convenience, Table 9.1 identifies the activity, cites the section which has provided the detailed discussion, identifies the process, gives a very brief description of it and cross-references the drawings presenting process flow diagrams. The "translation" of these processes into specific emissions sources is discussed in Section 9.1.3.

.2 Lease Requirements and Applicable Laws and Regulations

The following section discusses Lease provisions and Federal and State law and regulations applicable to the project and describes the actions which will be taken to comply with such requirements.

Lease Requirements. Section 11 of the Lease and Section 8 of the Lease Environmental Stipulations require compliance with all applicable Federal, State and local air pollution and air quality

ACTIVITY	SECTION/ SUB-SECTION	ITEM OR PROCESS	DESCRIPTION	DWG. NO.	BRIEF TITLE
Raw Shale Storage Stockpile and Handling	6.2 6.3 6.8 7.1	Raw Shale Handling & Storage Crushing & Screening Emissions Raw Shale Handling & Disposal	Conveying, transfer, crushing and screening, storage, wind erosion control & disposal of raw shale	EF220	Process Flow
MIS Gas Scrubbing & Compression	5.2.2	Offgas Scrubbing & Compression	Recovers oil and water from offgas and boosts pressure of low-BTU offgas for delivery to burners of steam boilers for combustion. 5 parallel gas trains. Ammonia also scrubbed.	EF201	General Block Flow Process Flow Diagram
Ammonia Stripping & Recovery (Phosam)	5.2.2	Offgas Scrubbing & Compression	Process condensate is water condensed out of retort offgas during precooling. This stage strips ammonia & recovers process condensate from above 5 gas trains.	EF204	Stripping/Recovery Process Flow Diagram
MIS Boilers & Flue Gas Desulfuriza-tion (FGD)	5.2.2	Offgas Scrubbing & Compression	5 trains of boilers, steam generators, FGD absorbers & slurry circulators. 2 boilers/stack. FGD unit is FMC double alkali unit.	EF203	Steam Plant Process Flow Diagram
Above-Ground Retorting (AGR)	6.4	Above-Ground Retorting	Heating medium & crushed shale are mixed into surge hopper/reactor where retorting takes place; solids then withdrawn & charged to lift pipe/combustor where carbon is burned off.	EF221	Lurgi Process Flow Diagram
Processed Shale Handling & Disposal	6.6 7.2 7.4	Proc. Shale Cooling & Conveying Proc. Shale Handling & Disposal Proc. Shale Placement & Compaction	Conveying, transfer, storage, wind-erosion-control & disposal of processed shale	EF222	Process Flow
General Arrangement	5.1	Surface Process Facilities	General arrangement of surface processing facilities	EM131	Plot Plan

TABLE 9.1 Activities and Processes Affecting Air Quality

Air Quality Control Plan

.2 Lease Requirements and Applicable Laws and Regulations (Continued)

regulations, including emission regulations limiting the quantities of air contaminants which can be emitted from various sources, and ambient air quality standards which define maximum permissible ground level concentrations of various air contaminants. Ambient air quality standards, which have been promulgated to protect public health and welfare, are of particular importance since they define the maximum permissible level of impacts from the proposed operations.

National Ambient Air Quality Standards. National Ambient Air Quality Standards (NAAQS) are shown on Table 9.2 generally representing values not to be exceeded more than once per year with the exception of ozone. Ozone is stated as the number of annual expected exceedances of one-hour-maximum values which must be less than 1.0 averaged over a consecutive 3-year interval. Annual particulate values represent the geometric mean of 24-hour values.

"Ambient" air according to 40 CFR 50.1 (e) is defined as "that portion of the atmosphere, external to buildings, to which the general public has access." For the present application, NAAQS and PSD standards are applied at the tract boundary (i.e., off-tract) corresponding to the pubilc-access location.

Pollutant	Averaging Time	Standard (ug/m^3)
SO_2	Annual	80(1)
	24-Hour Maximum	365
TSP	Annual	75(2)
	24-Hour Maximum	260
	8-Hour Maximum	10,000
	1-Hour Maximum	40,000
NO_2	Annual	100
O_3	1-Hour Maximum	235(3)

(1) Arithmetic Mean of 24-Hour Values

(2) Geometric Mean of 24-Hour Values

(3) Annual Expected Number of Exceedances Must be Less than 1.0 Over 3-Year Consecutive Interval.

Air Quality Control Plan

.2 Lease Requirements and Applicable Laws and Regulations (Continued)

Allowable PSD Increments. Allowable Federal PSD increments are presented on Table 9.3 for SO_2 and particulates. The C-b Tract is located in a Class II area. Federal increments for Class II apply off-tract. The nearest Class I area is the Flattops Wilderness area approximately 57 km away in an easterly direction. Class I increments must be met at the Wilderness area boundaries.

Regulated Pollutants and Their De Minimis Values. PSD regulations require consideration of all pollutants regulated under the Clean Air Act of 1977. As set forth in the August 7, 1980 changes to PSD regulations, Table 9.4 is a list of the regulated pollutants and their "de minimis values." The significance of the de minimis value is that those CB emissions above this value are subject to Best-Available-Control Technology (BACT) assessment. CB emissions are shown for comparison on Table 9.4.

Colorado Standards. Regulations, other than Federal, that the facility emissions must comply with, are the Colorado Air Quality Control Commission's regulations. These regulations control the emission of sulfur dioxide, hydrocarbons and particulates. The Colorado regulations also have set ambient standards for carbon monoxide, particulates, sulfur dioxide, nitrogen oxides and ozone at the identical level to the NAAQS.

TABLE 9.3

AIR QUALITY PSD INCREMENTS FOR SO_2 AND PARTICULATES

STANDARD	MAXIMUM ALLOWABLE INCREMENT (UG/M^3)				
	SO_2			TSP	
	3-HOUR	24-HOUR	ANNUAL	24-HOUR	ANNUAL
PREVENTION OF SIGNIFICANT DETERIORATION (PSD)					
FEDERAL					
CLASS I	25	5	2	10	5
CLASS II	512	91	20	37	19
CLASS III	700	182	40	75	37

TABLE 9.4 Regulated Pollutants & Their De Minimis Values (Tons/Yr)

Pollutant	De Minimis Emission Rate	CB Emission Rate
Carbon Monoxide	100	11,461*
Nitrogen Oxides	40	33,215*
Sulfur Dioxides	40	8,213*
Particulate Matter	25	3,066*
Ozone	40 of VOC	<40
Lead	0.6	0.15
Asbestos	0.007	0
Beryllium	0.004	0
Mercury	0.1	0.003
Vinyl Chloride	1.0	0
Fluorides	3	7.8
Sulfuric Acid Mist	7	0
Hydrogen Sulfide	10	0
Total Reduced Sulfur	10	0
Reduced Sulfur Compounds	10	0

*With Controls

.2 Lease Requirements and Applicable Laws and Regulations (Continued)

The State of Colorado regulates particulate emissions from point sources by a specified process weight rate curve for manufacturing processes. CB's Lurgi AGR units fall into this category. Each Lurgi retort would be considered a separate entity according to the State regulations. Since each Lurgi unit would process up to 8,800 tons per day of shale, the regulation would require the use of the following equation to compute the allowable emission rate:

$$E = 17.31\ P^{0.16}$$

where E = allowable emission in pounds/hour and P = process weight rate. The allowable emission would be:

$$E = 17.31\ \frac{8800\ \text{tons/day}}{24\ \text{hours/day}}^{0.16}$$

$$E = 44.50\ \text{pounds/day allowable emission/retort}$$

Each retort is allowed 44.5 pounds/hour of particulate emission; however, each retort will only emit 38.9 pounds/hour of particulate. Other sources of particulate such as the crusher screening building comply easily with the process weight rate standard due to the employment of BACT control. Fugitive dust emissions are to be controlled as outlined in Regulation 1, Section II, Subsection D through the application of BACT. Specific BACT controls are discussed in Section 9.1.3.

On February 5, 1981, the Air Quality Conrol Commission ammended it Regulations One and Six, dealing with SO_2 from oil shale facilities. The amendment is applicable to oil shale production facilities employing MIS and surface

.2 Lease Requirements and Applicable Laws and Regulations (Continued)

retorting technologies in combination such that at least 20 percent of the production comes from the surface retorting process. The amendment exempts such facilities from compliance with the non-Federal New Source Performance Standards (NSPS) of 0.3 pounds SO_2 per barrel of oil produced. The exemption will terminate in 1992 at which time compliance with the NSPS would be required or an extention must be granted by the Commission. Use of BACT control is required for SO_2 under this regualtion.

The Commission's regulations require the installation of floating roofs or equivalent on hydrocarbon storage tanks of 40,000 gallons or more. Storage tanks for CB will be constructed using vapor recovery, resulting in lower emissions than from floating roofs.

CB Baseline. It is appropriate to reference CB baseline (i.e. background) values of ambient concentrations inasmuch as these values are added to the PSD increments obtained from modeling to obtain a total value to demonstrate compliance with ambient standards.

From the Final Baseline Report and subsequent CB data reports, annual mean concentrations have been obtained for the criteria pollutants each year from 1975 thru 1980. These averages are

Air Quality Control Plan

.2 Lease Requirements and Applicable Laws and Regulations (Continued) presented on Table 9.5. On the basis of this extensive data set, background values utilized for demonstration with NAAQS are as follows:

SO_2 - 1 ug/m^3

TSP - 13

NO_2 - 2

CO - 856

O_3 - 81

.3 Emissions Inventory & Control Strategy

Pollutant Applicability. Referring back to Table 9.4, regulated pollutants and their de minimis values are indicated thereon. The column depicting CB emission rates indicates that carbon monoxide, nitrogen oxides, sulfur dioxide, particulate matter and fluorides are subject to BACT analysis in that they are above de minimis levels. Calculations of these numerical values are contained in CB's PSD permit to the EPA; that document is made part of this document by reference.

No gaseous emissions of fluoride are expected; rather, they are related to fluoride content in particulates. Therefore, BACT on particulates constitutes BACT on fluoride.

CONSTITUENT	1975	1976	1977	1978	1979	1980
SO_2	0.7	0.7	0.3	1.3	0.4	1.0
NO_2	1.3	4.2*	0.9	0.0	2.0	1.0
PARTICULATE**	10.7	7.4	8.3	9.1	13.3	8.3
CO	623	856	335	311	208	67
O_3	66.4	62.0	79.7	81.1	77.1	75.3

* <50% DATA

** GEOMETRIC MEAN

*** INSTRUMENT SPECIFICATIONS ARE GIVEN ON PP. A-178 AND A-179 OF VOLUME 2A OF THE 1979 C.B. ANNUAL REPORT. INSTRUMENTS USED ARE AS FOLLOWS:

ITEM	INSTRUMENT	SPAN OF USE
SO_2, H_2S	MELOY SA-185-2	NOV 74-MAR 77
	MELOY SA-135-2A	APR 77-PRESENT
CO	BENDIX 8500 CHROMATOGRAPH	NOV 74-AUG 78
	BECKMAN MODEL 866	SEP 78-PRESENT
NOX	MELOY NA-520-2 CHEMILUMINESCENCE	NOV 74-DEC 77
	MONITOR LABS MODEL 8440E NOX ANALYZER	JAN 78-PRESENT
O_3	MELOY OA-350-2 OZONE ANALYZER	NOV 74-MAR 79
	MELOY OA-350-2R OZONE ANALYZER	APR 79-PRESENT

Air Quality Control Plan

.3 Emissions Inventory & Control Strategy (Continued)

Control Strategy. A complete discussion on BACT analysis is beyond the scope of this RDDP but is contained in the commercial EPA PSD permit application, incorporated by reference. Control strategy is directly related to utilization of BACT.

Emissions Inventory. The general arrangement of emissions sources is presented on the plot plan (Figure 9.1) and on Drawing EM-102, including shale handling facilities; sources near the retorting and processing area are shown on Drawing EM-103.

Emissions for 45 fugitive dust sources are given on Table 9.6 along with each proposed control system and its percent efficiency; both uncontrolled and controlled emissions are listed. Similarly, seven SO_2 sources (as grouped for modeling) are presented on table 9.7.

Stack characteristics are given on Drawings EM-104 and EM-105.

In addition on Table 9.7, seven particulate point sources, seven CO point sources, and twelve NO_x point sources are shown.

Total controlled emissions are summarized on Table 9.8 for the entire on-tract facility.

FIGURE 9.1 PLOT PLAN - 15th YEAR

TABLE 9.6 AIR POLLUTION DATA FOR FUGITIVE DUST SOURCES

EMISSION SOURCE	PROPOSED CONTROL SYSTEM	EFF. %	POLLUTANT	UNCONTROLLED EMISSION		CONTROLLED EMISSION	
				TPD	TPY	TPD	TPY
Conveyor No. 1 (Partially covered)	Conv. cover & chemical spray	98.5	Raw shale fugitive dust	0.70	245.0	0.011	3.85
Conveyor No. 1A (Partially covered)	Conv. cover & chemical spray	98.5		0.70	245.0	0.011	3.85
Conveyor No. 1 & 2 Transfer pts.	Insertable baghouses	99.5	Raw shale pt. source dust	2.10	735.0	0.0105	3.67
Conveyor No. 1A & 2A Transfer pts.	Insertable baghouses	99.5		2.53	885.5	0.0126	4.43
Conveyor No. 2 (Partially covered)	Conv. cover & chemical spray	98.5	Raw shale fugitive dust	0.70	245.0	0.011	3.85
Conveyor No. 2A (Partially covered)	Conv. cover & chemical spray	98.5		0.845	295.8	0.013	4.55
Stacking tower-load-in	Baghouse	99.5	Raw shale pt. source dust	1.27	444.5	0.006	2.1
Stacking tower-load-in	Baghouse	99.5		1.27	444.5	0.006	2.1
Stacking tower-load-in	Baghouse	99.5		1.05	367.5	0.005	1.75
Stacking tower-load-in	Baghouse	99.5		1.05	367.5	0.005	1.75
Raw shale truck dumping to conveyor #14	None	0	Raw shale fugitive dust	0.0063	2.205	0.0063	2.205
Conveyor #14 (Partially covered)	Conv. cover	90		0.146	51.10	0.0146	5.11
Conveyor #14 Transfer pt.	Insertable baghouse	99.5		0.437	152.95	0.002	0.70
Conveyor No. 3A Bottom dump to stockpile (inside tunnel)	Chemical spray	85		0.108	37.8	0.0162	5.67
Conveyor No. 3 Bottom dump to stockpile (inside tunnel)	Chemical spray	85		0.108	37.8	0.0162	5.67
Conveyor #15 (Partially covered)	Conv. cover & 10% Moist. content	90	Processed shale fugitive dust	0.053	18.55	0.0053	1.86
Conveyor No. 3 (Partially covered)	Conv. cover & chemical spray	98.5	Raw shale fugitive dust	0.772	270.2	0.0116	4.06
Conveyor No. 3A (Partially covered)	Conv. cover & chemical spray	98.5	Raw shale fugitive dust	0.772	270.2	0.0116	4.06
Secondary & tertiary crushing and screening area	Baghouse	99.5	Raw shale pt. source dust	108.08	37,828.0	0.54	189.0
Conveyor No. 4 (Partially covered)	Conv. cover & water spray	95	Raw shale fugitive dust	0.772	270.2	0.0386	13.51
Conveyor No. 4A (Partially covered)	Conv. cover & water spray	95		0.772	270.2	0.0386	13.51
Conveyor #6 (Partially covered)	Conv. cover & water spray	95		1.544	540.4	0.0772	27.02
Conv. transfer pts. @ transfer tower area	Baghouse	99.5	Raw shale pt. source dust	12.18	4,262.0	0.061	21.35
Conveyor #15 Transfer point	Increase to 10% moisture content	0	Processed shale fugitive dust	0.079	27.65	0.079	27.65
Conveyor #15 Transfer point	Increase to 10% moisture content	0		0.079	27.65	0.079	27.65
30,000 ton fine stor. silo-load-in	Bin filter	99	Raw shale pt. source dust	0.91	318.5	0.009	3.15
30,000 ton fine stor. silo-load-out	Insertable baghouse	99.5		0.108	37.8	0.0005	0.175
30,000 ton fine stor. silo-load-out	Insertable baghouse	99.5		0.108	37.8	0.0005	0.175
Processed handling and disposal area	Wet scrubber	98	Processed shale pt source dust	14.48	5,068.0	0.29	101.5
Processed shale disposal - load in to storage bin	Increase to 10% moisture content	0	Processed shale fugitive dust	0.158	55.3	0.158	55.3
Processed shale disposal - load from bins to 120 ton trucks	Increase to 10% moisture content	0		0.0074	2.59	0.0074	2.59
Processed shale disposal - 120 ton trucks to stockpile (haulage)	Chemical spray	85		1.418	496.3	0.213	74.55
Processed shale disposal - stockpile dumping & wind erosion (uncovered)	Water spray; 50 ac max. exposed	50		0.436	159.0	0.218	79.57
Raw shale - stockpile loading & wind erosion (uncovered)	Water spray; 50 ac max. exposed	50	Raw shale fugitive dust	0.0157	5.72	0.0079	2.88
Conveyor No. 16 Transfer point	Increase to 10% moisture content	0	Processed shale fugitive dust	0.079	27.65	0.079	27.65
Conveyor No. 16 Transfer point	Increase to 10% moisture content	0		0.079	27.65	0.079	27.65
Conveyor No. 16 (Partially covered)	Conv. cover & 10% moisture content	90		0.053	18.55	0.053	1.86
Topsoil removal - scraper loader from	None	0	Native soil fugitive dust	0.062	16.15	0.062	16.15
Topsoil - stockpile dumping, scraping, shaping and wind erosion (revegetated)	None	0		NO EMISSION - FULLY REVEGETATED			
Topsoil - emission from vehicular traffic over processed shale stockpile	Chemical spray	85		0.0075	1.95	0.0011	0.385
Topsoil - dumping, scraping, shaping, wind erosion (uncovered) processed shale stockpile	None	0		0.05	13.0	0.05	13.0
Raw shale stockpile to conveyor No. 14 - vehicular traffic	Chemical spray	85	Raw shale fugitive dust	0.019	6.65	0.0028	0.98
Topsoil removal - scraper loader from raw shale pile	None	0	Native soil Fugitive dust	0.008	2.09	0.008	2.09
Topsoil - emission from vehicular traffic over raw shale stockpile.	Water spray	50		0.0003	0.078	0.00015	0.039
Topsoil - dumping, scraping, shaping, wind erosion from raw shale stockpile.	None	0		0.0064	1.67	0.0032	0.832

TABLE 9.7 AIR POLLUTION DATA FOR NON-DUST POINT SOURCES

Emission Sources	Proposed Control System	Efficiency %	Pollutant	Emissions w/o Controls		Emissions with Controls	
				TPD	TPY	TPD	TPY
Mine Exhaust Shaft #1	None	0	SO_2	0.096	35.0	0.096	35.0
	None	0	TSP	0.431	151.0	0.431	151.0
	None	0	NOX	1.60	584.0	1.60	584.0
	None	0	CO**	2.86	1,043.0	2.86	1,043.0
Mine Exhaust Shaft #2	None	0	SO_2	0.096	35.0	0.096	35.0
	None	0	TSP	0.431	151.0	0.431	151.0
	None	0	NOX	1.60	584.0	1.60	584.0
	None	0	CO**	2.86	1,043.0	2.86	1,043.0
FGD Stack #1	Flue gas desulfurization	95	SO_2	83.8	30,600	4.19	1,530
	Wet scrubber	100% except gas gen TSP	TSP			0.161	58.7
	Low NOX burner	89.3	NOX	1,551.0	5.67×10^4	16.6	6,070
	Incineration	100	CO			0	0
FGD Stack #2	same as source 52						
FGD Stack #3	" " " "						
FGD Stack #4	" " " "						
FGD Stack #5							
Eleven temp power generators	None	0	SO_2	0.001	0.348	0.001	0.348
	--	--	TSP		0		0
	None	0	NOX	0.124	45.2	0.124	45.2
	None	0	CO	0.590	216.0	0.590	216.0
Cement batch plant	--	--	SO_2	0		0	
	Baghouse	99	TSP	0.476	174.0	0.005	1.74
	--	--	NOX	0	0	0	0
	--	--	CO	0	0	0	0
Cement batch plant boiler	None	0	SO_2	0.025	9.04	0.025	9.04
	None	0	TSP	0.006	1.04	0.006	1.04
	None	0	NOX	0.003	1.22	0.003	1.22
	None	0	CO	0.003	1.04	0.003	1.04
Lurgi stacks #1 & #5	None, except scrubbed in liftpipe	0	SO_2	0.369	135.0	0.369	135.0
	Electrost. ppt.	99.9	TSP	1.26×10^3	4.59×10^5	1.26	459.0
	None	0	NOX	1.32	482.0	1.32	482.0
	None	0	CO	8.06	2,940.0	8.06	2,940.0
Lurgi stacks #2*, #6 and #7	None, except scrubbed in liftpipe	0	SO_2	0.552	202.0	0.552	202.0
	Electrost. ppt.	99.9	TSP	1.89×10^3	6.88×10^5	1.89	688.0
	None	0	NOX	1.98	723.0	1.98	723.0
	None	0	CO	12.1	4,410.0	12.1	4,410.0
Lurgi stacks #4 & #8	same as source 61						
Emissions from this Table:			SO_2	421.0	1,530,600.0	22.5	8,201.0
			TSP	4,411.0	1,606,500.0	6.1	2,204.0
			NOX	7,763.0	59,600.0	90.9	32,651.0
			CO	34.5	12,593.0	34.5	12,593.0
Emissions from Table EM101:			TSP	156.0	54,600.0	2.3	791.0
Total Emissions:			SO_2	421.0	1,530,600.0	22.5	8,201.0
			TSP	4,567.0	1,661,100.0	8.4	2,995.0
			NOX	7,763.0	59,600.0	90.9	32,651.0
			CO	34.5	12,593.0	34.5	12,593.0

*he modeling, 7 of 8 Lurgi's operate at once; #3 is arbitrarily assumed to be inoperative.

**d on highest 1-hour.

TABLE 9.8

Total Controlled Emissions from Primary Sources[6]

Constituent	gm/sec	lb/hr	TPD	lbs/bbl[1]	lbs/bbl[5]
SO_2-24hr & Ann	236	1870	22.5	0.38	0.29
NOX-Annual	956	7578	91.0	1.55	1.17
CO-1 hr[3]	362	2873	34.5	0.60	0.45
CO-8 hr[4]	330	2616	31.4	0.54	0.41
TSP-24 hr[2]	91	74	8.7	0.15	0.11
TSP Annual[2]	76	602	7.2	0.12	0.09

[1] Based on 117,000 bbls/day

[2] Based on year 25 shale pile development as worst case

[3] Based on worst 1-hour meteorology

[4] Based on worst 8-hour meteorology

[5] Based on 155,000 bbls/day which takes "credit" for 38,000 bbl gas-equivalent

[6] Small differences may exist between this table and accumulated values from Tables 9 -6 and 9 -7; values in these two tables are as-modeled.

Air Quality Control Plan

.4 Demonstration of Compliance with Air Quality Regulations

PSD Compliance. PSD compliance is demonstrated by comparison of air diffusion computer model results with the allowable PSD increments as presented on Table 9.3.

The EPA Valley Model utilized here is widely used in rough-terrian air diffusion modeling studies. It is both inexpensive and convenient to use for both short-term and annual non-reactive-pollutant studies.

The modeling approach taken was to use Valley Model in an initial screening mode to both indentify those meteorological conditions which resulted in high ground-level concentrations of the pollutant plume and to dismiss from further study those conditions for which concentrations were low. Actual meteorology including wind persistence was used. Then those few conditions resulting in high concentrations were subjected to further analysis using more refined models. For SO_2, a site-specific rough terrain model developed by AeroVironment was utilized.

In September, 1978, tracer studies were conducted at the C-b Tract as part of the AeroVironment model validation experiment. Model validation was undertaken in November, 1978. Appendix 6 of the PSD document contains the tracer studies in their entirety, and Appendix 7 the validation results. Both are incorporated here by reference.

Air Quality Control Plan

.4 Demonstration of Compliance with Air Quality Regulations (Continued)

For particulates (TSP), a dry-deposition term (using Stokes settling law), was included in the Gaussian diffusion equation of the Valley Model to readily accommodate the wide range of particle sizes characterized by the major emission sources.

Detailed modeling results are presented in the CB PSD application. These include:

1) examination of short term and annual results for both SO_2 and TSP for Class I and Class II as obtained from modeling CB commercial on-tract facilities;

2) additional effects of previously permitted sources:

Source	Size	Dist. from CB
Colony	47,000 bbl/day	20.9 km
Union	9,000 bbl/day	19.3 km
C-a	1,000 bbl/day	29.0 km
C-b (Ancillary)	5,000 bbl/day	0 km

3) secondary emissions from towns in the region and traffic along roads.

Results of this work are summarized on Table 9.9, where column 4 pertains to item 1 above, column 5 to the sum of 2 and 3, and column 6 to the sum from all sources. Column 6 is less than the PSD limit (Column 7) and compliance is therefore demonstrated.

PSD CLASS	POLLUTANT	AVERAGING TIME	MAXIMUM MODELING INCREMENT C-b	PERMITTED & SECONDARY SOURCES	TOTAL	LIMIT
I	SO_2	Annual	0.06	<0.10	<0.2	2
		24-Hour	<0.01	<0.47	<0.5	5
		3-Hour	<0.01	1.06	1.1	25
	TSP	Annual	0.03	<0.02	<0.1	5
		24-Hour	0.15	<0.13	<0.3	10
II	SO_2	Annual	15.6	0.1	15.7	20
		24-Hour	73	0.0	73	91
		3-Hour	303	0.0	303	512
	TSP	Annual	10	3.5	13.5	19
		24-Hour	29	4.4	33.4	37

Air Quality Control Plan

.4 Demonstration of Compliance with Air Quality Regulations (Continued)

Compliance with NAAQS. This is illustrated for SO_2. The background value for SO_2 is 1 ug/m^3 (Section 9.1.2). This is added to the maximum PSD increments to demonstrate complicance as follows:

Averaging Time	(1) Background (ug/m^3)	(2) PSD increment (ug/m^3)	(1) + (2) Total (ug/m^3)	NAAQS (ug/m^3)
24-hour	1	73	74	365
Annual	1	16 (rounded)	17	80

This is summarized in Table 9.10.

The background value for particulates is 13 ug/m^3. This value is added to the PSD modeled increments to demonstrate compliance with NAAQS as shown on Table 9.10.

One- and eight-hour CO concentrations were run to yield peak off-tract concentrations of 858 and 479 ug/m^3 respectively. When background values are added to these values the sums are well below the Federal standards of 40,000 and 10,000 ug/m^3 respectively, and compliance is demonstrated as shown on Table 9.10.

Annual NO_2 concentrations were run (as NO_x) yielding peak off-tract concentrations of 74 ug/m^3. When the background value of 2 is added to 74, the value of 76 is well below the NAAQS standard of 100 ug/m^3 and complicance is demonstrated as shown in Table 9.10.

Pollutant	Averaging Time	Max[1] Modeling Increment	Baseline	Sum*	NAAQS
SO_2	Annual	16	1	17	80
	24-Hour	73	1	74	365
TSP	Annual	14	13	27	75
	24-Hour	34	13	47	260
CO	8-Hour	479	856	1,335	10,000
	1-Hour	858	856	1,714	40,000
NO_2	Annual	74	2	76	100

*Sum = Modeling Increment Plus Baseline

(1) = Includes Permitted and Secondary Sources

Air Quality Control Plan

.4 Demonstration of Compliance with Air Quality Regulations (Continued)

Compliance with State of Colorado.Standards. These ambient standards are the same as the NAAQS.

Water Pollution Control Plan

This plan has been prepared to evaluate activiites which may contribute to water pollution, to review applicable Lease provisions, laws and regulations, and to set forth procedures which will be followed by the Lessee to assure compliance with appropriate requirements.

.1 Proposed Activities Affecting Water Quality

The potential for water pollution is present in all phases of activity. The major activities and facilities proposed in the RDDP which could affect water quality are: 1) construction, 2) mining, 3) processing facilities, 4) raw shale stockpile, 5) processed shale disposal, 6) on-tract product storage, and 7) off-tract facilities. These are described in detail in Sections 4.0-7.0. Any land surface modifications associated with construction and operation could cause an increase in stream sediment load. Low-quality ground water produced by dewatering of the shafts and development mining, if allowed to escape, could degrade stream water quality. Likewise, effluents from the mine shop and plant facilities could cause stream pollution. Uncontrolled runoff from the raw shale stockpile and processed-shale disposal area has the potential for contamination of surface

Water Pollution Control Plan

.1 Proposed activities Affecting Water Quality (Continued)

and ground water. Off-tract activities could also produce contaminated effluents.

Plans for controlling these potential sources of water pollution are described later in this section.

.2 Lease Requirements, Applicable Laws and Regulations and Control Plans

Lease Requirements. Section 11 of the Lease and Section 9 of the Lease Environmental Stipulations for Tract C-b require that the Lessee carry out all operations on the tract in compliance with Federal, State and local laws and regulations. The project will be subject to a number of water quality laws as described below.

Federal Laws and Regulations. Numberous federal laws and regulations deal in some way with water pollution control. The Federal Water Pollution Control Act (FWPCA), and amendments and regulations adopted by EPA under it provisions, will require 1) the preparation and implementation of oil spill contingency plans for storage tanks and pipelines, and 2) a National Pollutant Discharge Elimination System (NPDES) permit for effluents leaving the plant. While the project is expected to be a net consumer of water, the uncertainties relating to mine water inflow may require controlled discharge to Piceance Creek.

.2 Lease Requirements, Applicable Laws and Regulations and Control Plans (Continued)

Such discharges would require a NPDES permit. A spill contingency plan for oil and hazardous materials is included in Section 9.3.

Some parts of the Clean Water Act (CWA) -- specifically, Sections 208 and 106 relate to the protection of ground water. The Safe Drinking Water Act (SDWA), through its underground injection control and sole aquifer protection provisions, and the Resource Conservation and Recovery Act (RCRA) provide for control of certain hazardous practices and some protection for highly vulnerable areas. Other EPA statutes which regulate toxic substances and pesticides apply as well. Additionally, the Colorado River Basin Salinity Control Act limits salinity of the Colorado by regulation of discharges to contributing water systems.

State Laws and Regulations. The Colorado Water Quality Control Act and regulations thereunder establish stream water quality standards and discharge criteria for pollutants. The Act is administered by the Water Quality Division of the Colorado Department of Health. This division also administers the NPDES permit programs by agreement with EPA.

The Division and the Water Quality Control Commission administer and regulate the reinjection of water into underground disposal

.3 Plans and Procedures

wells, as well as underground disposal of wastes. Any disposal of water be reinjection or underground waste disposal requires public hearings and the approval of the Commission.

The following plans and procedures wil be implemented by the Lessee to avoid or minimize water pollution:

Contruction. Most of the impacts on the surface hydrological regime during the construction phase will result from modifications of the land surface. Land modifications will include the development of the mine and plant sites, establishment of processed shale and overburden disposal area, development of ore stockpiles, upgrading of existing roads and construction of new roads, service corridors, dams and reservoirs. Without mitigation, these activities could increase both runoff and sediment loads in Sorghum Gulch, Cottonwood Gulch, Scandard Gulch and the unnamed gulch west of Cottonwood Gulch, all of which are tributary to Piceance Creek. While it is difficult to quantify these potential increases, they should be proportional to the acreage disturbed.

Increased stream sediment load will result from increased erosion of disturbed areas. In an effort to minimize erosion, the Lessee will utilize the erosion control and surface rehabilitation plans presented in Section 9.10. In general, stream

Water Pollution Control Plan

.3 Plans and Procedures (Continued)

sediment load and siltation will be minimized by disturbing vegetation and the soil mantle as little as possible, contour-grading disturbed areas, installing catchments, and by initiating restoration activities as soon as feasible. The dams across Sorghum Gulch and Cottonwood Gulch will act as final sediment settling basins for the major construction sites.

Concentrations of total dissolved solids (TDS) in runoff from a disturbed area will be higher than that from the original undisturbed area. The retention dams across Sorghum and Cottonwood gulches will prevent the entry of most of this runoff into Piceance Creek.

Areas which are devoted to storage of construction fuels and chemicals wil be diked and spillage will be controlled. Sanitary sewage disposal during construction will be collected and treated in an aerobic treatment system, with disposal in leach fields or through sprinkler irrigation of vegetated areas.

Construction of the mine site, the processed shale embankment, catchment dams and other facilities will cause redistribution of infiltration to the ground water system in the vicinity of Sorghum Gulch. This redistribution may alter existing sub-surface water movement, but any alteration should not be

Water Pollution Control Plan

.3 Plans and Procedures (Continued)

serious since Sorghum Gulch contributes only nominally to the ground water system.

Mining. Shaft sinking, mine development and commercial mining will require dewatering of strata which have communication with the mine zone. Because of the low vertical permeability of the Four Senators zone and other rich oil shale layers above the mine zone, only limited amounts of ground water from isolated strata above the mine are expected to be produced. Aquifers below the mine zone will also be retarded by impermeable aquitards beneath the mining interval.

Ground water produced by the dewatering of the shaft and development mine could potentially cause stream pollution if uncontrolled. The procedures that will be used to handle the water produced by dewatering operations are described in detail in Section 5.3. In the event that large quantities of water must be removed from the aquifers above the mine zone, excess water will be disposed of by irrigation, reinjection, or discharge in compliance with applicable stream water quality criteria as reflected by NPDES permit requirements.

Once the plant is in operation, subsurface water in excess of that used within the mine for dust control will be pumped out of the mine area and used within the processing plant and in

.3 Plans and Procedures (Continued)

moisturizing and revegetating processed shale at the disposal area.

During active operations, all sanitary sewage from surface and underground facilities will be collected and treated in a package system. Treated effluent from the underground sewage systems would be brought to the surface and combined with similar waste for use or disposal as described in Section 5.3. Water from the shops which might contain hydrocarbons would be passed through a grease trap and then utilized for dust suppression.

Water used in crushing operations for dust suppression will be clarified to prevent plugging of spray nozzles. All water supplied to the crushing operation is expected to remain with the ore as it moves on the conveyor system.

Processing Facilities. Water management for processing facilities is described in detail in Section 5.3. The overall facilities configuration is based on maximum re-use and water conservation. The water management plan for continuous full-stream operation is based on zero discharge, with treated process waste-waters being used for on-site requirements. The treatment and disposition of blowdowns and sludges are detailed throughout Section 5.3.

Water Pollution Control Plan

.3 Plans and Procedures (Continued)

All areas where there is a risk of major oil spills will have provisions for containement in accordance with applicable environmental regulations, the Occupational Safety and Health Act, and the National Fire Prevention Code as described in Section 9.3. Areas where there is a risk of minor spills, such as truck loading and unloading areas, will drain into an oily-water sewer system which feeds into the mine water API separator. Rain water drainage from non-oily areas will be filtered through hay bales as a final precaution against oil contamination and directed to the Sorghum Gulch Reservoir or to the general services pond.

Processed Shale. Because no discharge of water is planned from the project, the most serious potential source of water pollution is from leaching of processed shale, both on the surface and in the MIS retorts. The handling and disposal of processed shale are discussed in detail at Sections 6.0 and 7.0.

Raw shale from mine development drifts and the void areas of the MIS retorts will be brought to the surface to be retorted aboveground. The processed shale from this operation will contain relatively high concentrations of soluble salts. Depending upon the retorting conditions, the shale may contain

.3 Plans and Procedures (Continued)

soluble sodium oxides, slightly soluble calcium and magnesium oxides, and trace elements which are not volatilized during retorting. To prevent pollution of the water resources by these contaminants, containment of the runoff and leachate from the processed shale pile will be required. Containment will be effected by way of a system of engineered drainage and runoff controls as described in Sections 6.0 and 7.0. Drainage and runoff from the processed shale pile will be collected and neutralized for shale moisturization, and such other uses as might be available within the overall constraints of surface water discharge criteria. Catchment basins for processed shale leachate and runoff will be designed for minimum infiltration, and can be lined if necessary to restrict any potential for groundwater inflow.

Groundwater contamination from modified in-situ retorts is a potential problem, however results of studies to date are encouraging to the point of suggesting that such contamination at Tract C-b is likely to be inconsequential from a water use standpoint.

Insofar as inorganic constiutents are concerned, owing to the combination of relatively high retorting temperatures (1600+°F) and extended contact times, the modified in-situ process yields a retorted shale characterized by the presence of insoluble

Water Pollution Control Plan

.3 Plans and Procedures (Continued)

a retorted shale characterized by the presence of insoluble silicate materials. Laboratory studies performed by Occidental Research verify the fact that at temperatures above 700°C all carbonates are converted to silicates, mainly akermanite ($Ca_2MgSi_2O_7$), and diopside ($CaMgSi_2O_6$). The kinetics of the process are enhanced by the injection of steam, as will be the case at Tract C-b. Leaching studies on both laboratory-retorted pellets and retorted shale cores from Retort 3E at Occidental's Logan Wash demonstration site shown good agreement. Thus, careful process control comprises a first line of defense; effectively a form of built-in pollution control technology.

In terms of actual field experience with operating retorts, a comprehensive monitoring program was put in place prior to the ignition of Retort 6 at Logan Wash. The same general sampling format will be followed for Retorts 7 and 8 during November 1981 through the latter part of 1982. The program for Retort 6 required monitoring of streams and other surface waters, alluvial and bedrock wells, and satellite wells around the retort for an extensive list of constituents. Subsequent analyses of process water and monitoring point samples allowed the selection of five parameters which would serve as reliable indicators of any contamination by process waters; NH_3, phenols, Kjehldahl-N, organic carbon, and carbonate.

Water Pollution Control Plan

.3 Plans and Procedures (Continued)

to summarize the results of monitoring before and during the processing of Retort 6, no statistically significant changes in surface water quality, or evidence of changes in water quality of alluvial wells have been observed. No sign of changes in water quality of deep wells resulting from retorting activities has been noted. Satellite wells around Retort 6 showed significant changes in water quality resulting from collapse of the sill pillar, and infiltration of surface water through the retorted air level. However, contamination was limited to wells within the zone immediately surrounding the retort. Overall, evidence to date points to the fact that process water infiltration has been restricted to the immediate vicintiy of the retort. That measurable contamination occurred at all is thought to be the result of surface water inflow to the air level drift which had been "retorted" to some extent as a result of sill pillar failure. Sampling and testing of wells down dip from Retort 6 are continuing in order to detect any transport of retorted shale products which might occur over a longer period of time.

The chemistry of organic constituents of in-situ processed shale and their leaching characteristics are not well known. Based on studies at Occidental Research, it is known that the lowest concentrations of organic contaminants occur in leachate

Water Pollution Control Plan

.3 Plans and Procedures (Continued)

derived from processed shale produced via high-tempurature retorting with no recycle gas--conditions which are typical for Oxy's modified in-situ process. Thus, except for unretorted bottoms, and nonuniformities within burned retorts, in-situ processed shale should contain very little organic carbon, and in any event, the quantities of potential organic contaminants are very much smaller than the inventory of inorganic materials.

As is the case for inorganics, results from leaching studies using simulated retorted shale are encouraging insofar as ultimate environmental consequences are concerned. Most of the organic carbon is solubilized after passage of the first few pore volumes of water through leaching columns. Based on these observations, deliberate leaching of in-situ retorts wil be investigated as a potential control technology. With an ongoing operation, water might be pumped through the abandoned clusters, and the effluent collected for treatment and subsequent reuse.

Mitigating Factors/Strategies. Overall, recognizing the uncertainties associated with modified in-situ processing, there are a number of mitigating factors and/or management strategies which are capable of rendering the groundwater contamination issue more-or-less a non-problem in the real sense:

1) Major components of in-situ processed shale leachate are SO_4, HCO_3, CO_3, Na, Cl, Si, and K; these ions are not

Water Pollution Control Plan

.3 Plans and Procedures (Continued)

highly toxic, are not detrimental for many water uses, and may be tolerated at rather high levels. Minor components include As, Pb, F, phenols and organo-nitrogens.

2) Groundwaters in the Piceance Basin are not extensively used; most users rely on alluvial aquifers, and therefore, short term effects should not be serious.

3) The effects, if any, of in-situ leachates will not be immediate. The time required for groundwater to enter and leach retorts and surface waters will be on the order of decades to centuries.

A recent Lawrence Berkeley Laboratory report for the Department of Energy contains calculations for a hypothetical retort at Tract C-b releasing leachate over a period of 6 to 54 years. Moving at 20-30 feet per year through the upper aquifer could involve 200 years before discharge to the nearest stream.

4) Occidental's experience at Logan Wash has not shown any measurable contamination outside the immediate area of the in-situ retorts.

5) Operating procedures offer the opportunity to minimize the formation and/or accumulation of potential contaminants. Present information points to control of the modified in-situ process for high temperature conversion of both

Water Pollution Control Plan

.3 Plans and Procedures (Continued)

organic and inorganic constituents as the first line of defense.

6) Management practices can be developed to effectively prohibit the long-range transport of leached materials. These involve deliberate leaching, and subsequent treatment and reuse and/or isolation of effluents. Dewatering of retort zones and subsequent isolation of retorts from the aquifer system will occur through the commercial life at Tract C-b, and if deemed necessary, could be continued over the long-term.

7) In the unlikely event that the developing oil shale industry were to experience economic and/or technological problems to the point of curtailment, the inventory of potential leachates will not likely be significant.

Supporting Off-tract Facilities. Suporting off-tract facilities include roads, power lines, product and by-product pipelines, waterlines, and terminal facilities. After construction is complete, the potential for water quality degradation from these facilities is low.

Terminal facilities will consist primarily of offices, a rail spur, loading docks, and some tankage. Potentially contaminated wastewater and sanitary sewage from these facilities will be

Water Pollution Control Plan

.3 Plans and Procedures (Continued)

either treated nd disposed of in leach fields, or pretreated as required and conveyed to local domestic treatment systems.

Spill Prevention Control and Counter-Measure Plan

The potential for accidental spills or release of oil and other hazardous materials exists as a result of the Lessee's development of the tract and associated off-tract pipelines and terminals. This plan summarizes the potential source of accidental spills; reviews the current regulations and standards that would apply to the Lessee's activities; defines and inventories the hazardous materials within the plant; and presents the Lessee's spill prevention, control and contingency plans for the plant and associated pipelines.

In addition to the plan described here, the Lessee has prepared other plans which discuss certain aspects of oil and hazardous materials spill prevention control. They are:

- Air Pollution Control (Section 9.1)
- Water Pollution Control (Section 9.2)
- Fire Prevention and Control (Section 9.4)
- Disposal of Other Wastes (Section 9.5)

.1 Activities and Processes Which May Result in Potential Spills

During construction activities, spills of diesel fuels and other fuels and lubricants are possible during transportation,

Spill Prevention Control and Counter-Measure Plan

.1 Activities and Processes Which May Result in Potential Spills (Continued)

loading and unloading operations, both on-tract and at construction staging areas and rail spurs. Dust suppressants and smaller amounts of miscellaneous chemicals used during construction activities also pose pollution threats if quantities of these materials reach drainages or flowing streams near the tract.

The on-tract storage of approximately 350,000 barrels of shale oil poses the greatest potential spill volume. In the handling of large volumes of hydrocarbons, some small leaks or spills can be expected. Collection structures will be used to contain leaks and spills.

Refinery experiences have shown that large spills usually can be eliminated by proper operating procedures and a careful maintenance program. Storage of raw shale oil in large storage tanks also provides the potential for large accidental releases. Proper diking and sizing of storage areas will prevent spills from tanks from reaching flowing streams. By-products such as ammonia also pose potential spill problems, but on a much reduced scale since its production volume is small compared to shale oil.

The pipelining of oil and by-products is another potential source of spills, although pipelines are probably the safest method of

Spill Prevention Control and Counter-Measure Plan

.1 Activities and Processes Which May Result in Potential Spills (Continued)

transporting large volumes of gases and liquids. Most pipeline leaks result from older pipelines which have undergone corrosion and aging. The shale oil pipeline and possible by-product pipeline will be new lines and extensive cathodic protection will minimize corrosion of these lines.

The trucking, loading and unloading of hazardous supplies during plant operations as well as the trucking of ammonia from the plant will also be potential sources of accidental spills.

Following the operational phase, the potential for volume spills will be greatly reduced and will be limited to such things as fuel and lubricants used during dismantling and restoration activities.

.2 Regulatory Requirements

Section 7 of the Lease Stipulations requires that spill contingency plans for oil and other hazardous substances be submitted with the DDP and that these plans conform to the National Oil Hazardous Substances Pollution Contingency Plan, 36 FR 16265, August 20, 1971, as amended. The national plan was developed by the Council on Environmental Quality in compliance with the Federal Water Pollution Control Act 33USC 1251. It has since been amended on September 9, 1972 (37 FR 184411), and December 21, 1972 (38 FR 2808). Because the federal government has

Spill Prevention Control and Counter-Measure Plan

.2 Regulatory Requirements (Continued)

vested jurisdiction of Spill Prevention Control and Counter-measure (SPCC) plans in the U.S. Department of Transportation (U.S. Coast Guard) for transportation-related facilities, and in the Environmental Protection Agency (EPA) for non-transporation related facilities, the Lessee will have prepared and will implement such SPCC plans at the time oeprations commence in accordance with the regulations of the U.S. Coast Guard (USCG) and EPA. These plans will be submitted to the OSO after engineering design has been completed. Special notice is recognized in the Oil Shale Lease Environmental Stipulations Section 2, E through H and Section 7, D. These deal with Pipeline Cosntruction Standards, Pipeline Safety Standards, Shut-off Valves, Pipeline Corrosion, and Storage and Handling Standards. A brief summary of the jurisdictional aspects of SPCC plans is presented below.

Spill regulations fall in two classes: (1) oil, and (2) other hazardous substances. Regulations concerning oil spills have been extensively developed and codified. Federal government jurisdiction has been split between the EPA and the U.S. Coast Guard (USCG), with EPA originally designated as responsible for inland waters and USCG for coastal waters and ports. A subsequent memorandum of understanding between the Secretary of Transportation and Administration of the EPA (FR Doc. 73-25448, December 10, 1973) assigned responsibility for all "transportation related

Spill Prevention Control and Counter-Measure Plan

.2 Regulatory Requirements (Continued)

onshore and offshore facilities," including pipelines, to the USCG. In 39 FR 41989, December, 4, 1974, the USCG extended its jurisidiction to the "entire riverine system, extending upstream to the sources," thus clearly encompassing inland pipeline spills which result in water pollution. The EPA has published (38 FR 237-34164, December 11, 1973) regulations and guidelines requiring that owners of non-transporatation-related facilities, which could conceivably spill oil into the waters of the nation, prepare and implement an SPCC plan within six months after a facility first commences operation. The USCG has not yet made mandatory such a requirement for transporation-related facilities.

For administrative purposes, oil spills in inland waters are classified (38 FR 21889) as minor if they range from 1000 to 10,000 gallons and major if over 10,000 gallons. Discharge of hazardous substance in a "harmful quantity" has yet been defined, but the definition would have to be related to the size of the stream or body of water involved, velocity of flow or diffusion, toxic concentration, etc. Discharges of oil or hazardous substances that either generate critical public concern or pose a substantial threat to public health or welfare are classified herein as major regardless of the quantities involved.

Because of the as-yet undetermined nature of hazardous materials definitions and regulations, it will be assumed for the purposes

Spill Prevention Control and Counter-Measure Plan

.2 Regulatory Requirements (Continued)

of this spill plan that:

- any and all chemicals not obviously oils will be classified as hazardous materials;
- any release of such materials to a waterway will be assumed harmful and require corrective action; and
- required elements for a hazardous material SPCC plan will be the same as for oils.

.3 Hazardous Materials Definitions

Regulations comparable to those requiring an SPCC plan for potential spills of oil have not yet been developed for the control of pollution by spills of hazardous materials other than oil. EPA has taken the first step by proposing a tentative list of hazardous materials (39 FR 30466, August 22, 1974, "Designation and Determination of Removability of Hazardous Substances from Water").

In 39 FR 30466, EPA has proposed certain criteria for placing a material in the hazardous classification for water pollution. The Federal Water Pollution Control Act provides that such a classification be developed for "such elements and compounds which, when discharged in any quantity into or upon the navigable waters of the United States or adjoining shorelines or the waters of the contiguous zone, present an imminent and substantial danger to the public health or welfare, including but not

Spill Prevention Control and Counter-Measure Plan

.3 Hazardous Materials Definitions (Continued)

limited to fish, shellfish, wildlife, shorelines, and beaches." The proposed criteria include an element or compound produced in excess of research quantities. Such elements or compounds possess sufficient danger potential to be considered as a candidate hazardous substance if it is lethal to: 1) one-half of a test population of aquatic animals in 96 hours or less at a concentration of 500 milligrams per liter (mg/l) or less; 2) one-half of a test population of animals in 14 days or less when administered as a single oral dose equal to or less than 50 milligrams per kilogram (mg/kg) of body weight; 3) one-half of a test population of animals in 14 days or less when dermally exposed to an amount equal to or less than 200 mg/kg body weight for 24 hours; 4) one-half of a test population of animals in 14 days or less when exposed to a vapor concentration equal to or less than 200 cubic centimeters per cubic meter (volume/volume) in air for one hour; or 5) aquatic flora as measured by a 50 percent decrease in cell count, biomass or photosynthetic ability in 14 days or less at concentrations equal to or less that 100 mg/l.

To be further considered for designation as a hazardous substance, any element or compound meeting the above criteria must have a reasonable potential for being discharged, i.e., spilled into a water body. Factors being considered in making this

3 Spill Prevention Control and Counter-Measure Plan

.3 Hazardous Materials Definitions (Continued)

evaluation include the production quantities, modes of transportation, handling and storing practices, past spill experiences and physical-chemical properties of each substance.

Two types of "spills" are being considered. The first relates to incidents occurring during transporations, storage and use in which there is normally no release of substance except during a spill. The second relates to industrial production facilities in which a designated hazardous substance is normally released in permitted quantities in an effluent stream governed by an NPDES permit. An increase in effluent concentration above the permitted level would be classified as a hazardous spill.

.4 Oil and Hazardous Materials Inventory

A list of substances present in substantial quantities within the shale oil plant is presented below. The list identifies substances stored both on and off-tract which would be classed as pollutants if allowed to escape. The list does not include an evaluation of the possibility of such an occurrence.

Material Stored	Commercial Operations Storage Capacity (BBL)	1979 Storage (BBL)	1980 Storage (BBL)
On-Tract			
Process Retort Water Stripper Feed	113,000	0	0
Process Condensate Water Stripper Feed	150,000	0	0

Spill Prevention Control and Counter-Measure Plan

.4 Oil and Hazardous Materials Inventory (Continued)

Material Stored	Commercial Operations Storage Capacity (BBL)	1979 Storage (BBL)	1980 Storage (BBL)
On-Tract			
Plasticrete	200	50	50
Diesel Fuel	7,500	830	2,950
Gasoline	2,000	35	645
Chlorine	100	10	10
Oil-Water Separator Liquid	2,000	0	0
LPG	2,000	190	850
Ammonia	24,000	0	0
Shale Oil	660,000	0	0
Sulfuric Acid	200	30	100
Off-Tract			
Shale Oil	60,000	0	0
Ammonia	3,000	0	0

Storage capacities shown are for net contents and do not include allowances for heel or vapor space. These capacities are based on production of 94,000 barrels per day of shale oil. Higher or lower production rates would modify tank capacities accordingly.

In addition to the stored materials, certain other materials and liquid streams may be present which could also be classed as potential pollutants, if the materials escaped. Examples of such materials include retort sour water which contains ammonia and various catalysts and miscellaneous chemicals. Process effluents will be used for process water as rapidly as possible, and therefore, require only small quantities in storage.

Spill Prevention Control and Counter-Measure Plan

.5 Oil Pipeline SPCC Plan

A SPCC plan will be prepared for all product pipelines connecting with the tract upon completion of final selection of the specific route and design of the pipeline. The submittal of a plan containing the indepth technical details for the C-b product spur line is not feasible at this time.

The containment and countermeasure procedures established for the pipeline will emphasize, in areas other than where preconstructed diking systems are employed, bringing trained men and equipment to the scene as quickly as possible to analyze spills and initiate the established correction procedures. The route chosen for that pipeline will be such that containment and cleanup of any oil spill would most likely be on land. However, if the pipeline does cross a river, both land and water containment procedures must be considered. Automatic shut-in at major stream crossings will be used.

Although each potential oil spill location would call for individual consideration of techniques to be employed, the general methods described below are applicable to the overall system and route.

Source Control. On-site source control will be critical. The source control procedure involves closing of manual valves and immediate repair, permanent or temporary, of the damaged or

Spill Prevention Control and Counter-Measure Plan

.5 Oil Pipeline SPCC Plan

malfunctioning equipment. Some sites may warrant more rapid shut-in by automatic or remote valve drives.

Control of the Spread of Oil. Varying physical conditions required a wide variety of methods and equipment to control spreading oil. In addition, the time lag involved for arrival of men and equipment will effect the type of control methods to be used. Surveillance and communication will be critical to the effective control of the spread of oil.

The general technique used to control the spread of oil involves constructing dikes or diversion ditches, employing booms or barriers (when the oil spill has reached water), use of absorbents (such as straw and commercial products, usable on both land and water) and the use of chemicals to disperse or coalesce the oil on water (restricted by regulation). If the release of oil is necessary to make repairs on the system, temporary, lined ponds or mobile containers will be utilized to hold any oil released.

The plan will contain extensive cleanup and removal procedures. The basic components of these procedures include collection and recovery of oil and contaminated debris, removal of soil and vegetation, and cleanup of the affected area. Contaminated debris, soil and vegetation would be handled by a commercial solid waste disposal company.

Spill Prevention Control and Counter-Measure Plan

.6 Hazardous Materials Pipeline SPCC Plan

The SPCCP for hazardous materials pipelines, required for by-products such as ammonia and propane, would be similar to that described above for the oil pipeline, with the major difference beng that the material passing through these pipelines will gasify when exposed to the ambient air, and will not spill out as a liquid. For this reason, the control measures to be undertaken in the case of a pipeline malfunction or damage would consist primarily of shutting off the valves nearest to the damaged area, much as the control measures used with a natural gas pipeline. No confinement techniques will be needed, but notifying and evacuating people near problem area will have to be evaluated. Detection of leaks from the pipeline will be by visual observation and pressure monitors on the pipeline. Any leakage will be apparent from the frosting up of the pipeline and surrounding area.

Cleanup and disposal measures generally will not be needed due to the gaseous form of the material. The gas will escape to the atmosphere. This presents the additional threat of the potential for combustion of the gases while concentrated in the area. Special precautions will be taken to ensure that no flames are present in

Spill Prevention Control and Counter-Measure Plan

.6 Hazardous Materials Pipeline SPCC Plan (Continued)

the area following a leak, and the use of any motorized vehicles will be minimized. Following closing of the valves above the leak, the area will be restricted for enough time for the gases to disperse.

.7 SPCC - Response Plan

Basic requirements of acceptable SPCC plans, which are conventional and universally used in refineries and pipelines, include such information as the name and location of the facility and names of responsible personnel, storage or handling capacities and daily throughput, storm water runoff capability, facility description with flow diagrams and topographical maps, analyses of risks, and prevention or corrective measures to be taken. Much of this information will not be available unitl a detailed engineering design of the facility has been completed. The SPCC plan set forth here is descriptive in nature of the present plans, and is subject to modification as becomes necessary before the facility goes into operation. The SPCC plan will become effective at the time of start-up of the plant. The plan will be reviewed and certified by a registered professional engineer. A copy of the plan will be maintained at the plant and will be available for review by authorized parties.

Spill Prevention Control and Counter-Measure Plan

.7 SPCC - Response Plan (Continued)

Notification. In the event of an accidental spill of oil or other hazardous material reaching or having the potential of reaching a waterway, various government entities must be notified. Activation of regional or national spill response teams may then be initiated as required according to the respective regional or national spill contingency plans. Spills occurring on or in the immediate vicinity of the tract would require the following notifications:

Environmental Protection Agency (EPA)
Region VIII
Denver, Colorado
(303) 836-3880

ALSO: National Response Center (800) 424-8802

Colorado Department of Health
Water Quality Control Division
Denver, Colorado
(303) 320-8333 Ext. 3459 or Ext. 3477 8:00 a.m. - 5:00 p.m.
Non-duty hours: Roger Smades 985-2735 or Fred Matter 690-7462
For Radioactive Hazardous Materials - 320-1465 or Al Hazie 422-4146 after hours.

Oil Shale Office (OSO)
131 N. 6th
Grand Junction, CO 81501
(303) 245-6700

Pipeline or transportation-related spills would also be reported to:

U.S. Coast Guard, 2nd District
St. Louis, Missouri
(314) 622-4614

If spill occurs in surface waters with a possibility of harm to fish or other wildlife, notification would be made to:

Spill Prevention Control and Counter-Measure Plan

.7 SPCC - Response Plan (Continued)

Colorado Division of Wildlife
Denver, Colorado
(303) 825-1192

If contamination of public water supplies is possible, notification would be made to:

Water Quallity Control Division
Denver, Colorado
(303) 320-8333 Ext. 3459 or Ext. 3477

If it is necessary to move a large number of vehicles or to control traffic at any location, notification would be made to:

Colorado Highway Department
State Patrol
Denver, Colorado
(303) 757-9011, Ext. 401

All spills would be reported to the oil shale office. Other government agencies to be notified in certain cases include:

Bureau of Land Management
Grand Junction District
(303) 242-8515

Bureau of Land Management
455 Emerson Street
Craig, Colorado
(303) 823-3289

U.S. Forest Service
Denver, Colorado
(303) 233-6186

Local city, fire, police and health departments. Also, see Table 9.11 which is a Colorado Department of Health memo concerning spill reporting.

TABLE 9.11

Colorado Department of Health
Water Quality Control Division

SPILL REPORTING

Colorado State Law, 1973 (CRS (1973) 25-8-601) in part requires notification to the Water Quality Control Division, Department of Health, of the spillage of any material which may cause pollution of waters of the state. This notification must be made by telephone as soon as is practicable. Failure to notify or delayed notification is punishable by a fine of up to $10,000.00 and/or by imprisonment for up to one year. In addition to reporting a spill, the company responsible should take immediate corrective action to contain and/or remove the substance spilled.

The Federal Water Quality Control Act Amendments of 1972, in part, state that any spill of an oil or hazardous material into navigable waters must be reported immediately to the appropriate federal agency. Failure to report the spill carries a fine of up to $10,000.00 and/or one year imprisonment. In addition, any spill of oil or hazardous material to navigable waters shall be assessed a civil penalty by the Coast Guard in an amount not to exceed $5,000.00.

When a spill of any material occurs which does or may reach any water of the state, surface or groundwater, the spill must be reported immediately by telephone to the following, listed in order of preference:

1. Normal Duty Hours - 8:00 a.m. - 5:00 p.m.

   Colorado Department of Health
   Denver, Colorado - Telephone 320-8333, Ext. 3459 or Ext. 3477

2. Non-duty Hours

   Roger Smades - 985-2735
   Fred Matter - 690-7462 If unable to reach either one, call 320-1465

TABLE 9.11 (Continued)

3. If spills are of radioactive hazardous material

   Call 320-1465 or Al Hazie - 422-4146 during non-duty hours.

4. U.S. Environmental Protection Agency

   Denver, CO 837-3880 (24-hour contract)

In the event you are unable to contact the State Water Quality Control Division or its personnel, notification of the U.S. Environmental Protection Agency will suffice.

SPILL REPORTING

NOTE: This supersedes some of the instructions in the Manual for Reporting Spills, dated January, 1975 and the Spill Reporting Sheet dated December 15, 1978.

9.3 Spill Prevention Control and Counter-Measure Plan

.7 SPCC - Response Plan (Continued)

Spill Response Team. All spills not involving the product oil pipeline will be responded to by an in-plant spill response team which will be specially organized and trained for this purpose. A Spill Response Coordinator (SRC) will have the primary responsibility for deciding the action required and assembling the necessary team elements. A designated SRC will be available at all times.

When a spill or indication thereof is first observed by plant personnel, it will be reported through the operations control center and the dispatcher will then contact the SRC directly. The magnitude of the spill or the sensitivity of the area in which the spill occurs will determine the reporting procedure to be followed and the participating units required. If a spill should be reported first by an outside observer, the switchboard operator receiving the report would transfer the call directly to the SRC, if possible.

For a small spill, where cleanup will be routine and natural entrapment has already occurred, cleanup activities may be handled within the operating department where the spill occurred and the SRC will not call upon other memebers of the spill team. If a large spill occurs, then more people will become involved. Definitions of some team responsibilities follow.

9.3 Spill Prevention Control and Counter-Measure Plan

.7 SPCC - Response Plan (Continued)

The SRC has the overall management responsibility for all activities related to safe control, containment, cleanup and mitigation of the environmental effects of any spill, along with the necessary restoration of facilities, liaison with governmental agencies and public relations.

The Cleanup Coordinator has the responsibility to study and review cleanup activities from past spills, both large and small, to be constantly aware of new developments in clean-up methods equipment and materials, and to have an in-depth knowledge of the behavior of oil and other hazardous materials when spilled.

The Government Liaison Coordinator has the responsibility for liaison with federal, state and local enforcement agencies, both before and during spills.

The Public Relations Coordinator has the responsibility for presenting accurate and factual information to the public during a major environmental incident.

The Legal Coordinator has the responsibility to ensure that all contracts and agreements with outside cleanup contractors are in sound legal form and in compliance with applicable laws, rules and regulations, and to coordinate the activities of insurance representatives.

9.3 Spill Prevention Control and Counter-Measure Plan

.7 SPCC - Response Plan (Continued)

The Environmental Protection Coordinator has the responsibility to ensure that all containment, cleanup, restoration, wildlife rehabilitation and other activities are conducted in an environmentally sound manner. He wil coordinate with the environmental investigators from government agencies.

The Procurement and Logistics Coordinator has the responsibility for procurement of company-furnished personnel, equipment and material to provide logistical support necessary at the scene.

The Documentation Coordinator has the responsibility to ensure that all aspects of activities are properly documented and recorded, both in writing and visually (photographs, movies, maps).

The Accounting Coordinator has the responsibility to ensure that all aspects of financial activities are properly handled, documented and recorded.

Coordinators for other activities also may be required, such as a technical evaluator for new equipment, food, housing, and transportation. The Safety and Security Coordinator has the responsiblity for fire-damage control, emergency services, restriction of access and documentation.

9.3 Spill Prevention Control and Counter-Measure Plan

.7 SPCC - Response Plan (Continued)

Formal training sessions will be held for all personnel with supervisory or staff responsibilities for spill response and cleanup. The key elements of these training sessions will involve:

- a printed organization chart of the response team showing all job titles.
- a formal and detailed description of each job.
- a series of seminars for each job, including oepration of actual cleanup equipment, radios, etc., where appropriate
- a periodic refresher and updating session, perhaps on a yearly schedule.

Table 9.12 lists current (February, 1981) spill response team members.

.8 In-Plant Spills

Prevention. The first step in preventing spills is to analyze the potential which exists. The objective of such an analysis is to identify facility weaknesses and to make engineering modifications which can significantly raise the level of spill prevention in the overall facility design. Statistics show that about 88% of facility spills are the result of operator error, 10% are due to mechanical failure and 2% to all other causes. Thus, the area having the greatest possibilities for improvement is increased operator reliability.

TABLE 9.12 Spill Response Team

Spill Response Coordinator	W. C. Langford
Cleanup Coordinator	S. L. Stringer
Government Liaison Coordinator	E. B. Baker
Public Relations Coordinator	S. M. McClain
Legal Coordinator	D. R. Hale
Environmental Protection Coordinator .	E. B. Baker
Procurement and Logistics Coordinator .	G. Jay
Document Coordinator	T. H. Pysto
Accounting Coordinator	S. J. Swarzendruber
Training Coordinator	F. H. Abernethy
Safety and Security Coordinator	D. L. McClung

9.3 Spill Prevention Control and Counter-Measure Plan

.8 In-Plant Spills (Continued)

Operator reliability will be stressed when training new personnel who will be involved with transferring materials in the plant. Operating procedures for prevention of conditions and incidents leading to spills will be periodically reviewed. Another method of increasing operator reliability is through the use of additional warning and monitoring systems within the plant such as level alarms, back flow indicators, etc. An external human factor is the possibility of vandalism such as the opening valves, etc. Within the plant proper, with large numbers of employees present at all hours, the risks of vandalism should be relatively remote. At any outlying locations where unattended tanks or pipeline valves might be located, extra security precautions (fences, lights, regular patrols and locks) may be justified.

The overall design of the proposed oil shale processing complex will be unusually resistant to accidental spills which could have a significantly harmful effect on the environment. All large tanks will be diked to provide first-order protection in case of tank failure, accidental over-filling, etc. The dikes and all other liquid-containing systems will be designed to American Petroleum Institute standards as described in API Bulletin D16, First Edition, March 1974, and will be conventional structures of the type used in refineries. The

9.3 Spill Prevention Control and Counter-Measure Plan

.8 In-Plant Spills (Continued)

methods and results of their use is widely known and accepted. In addition, all storm drainage from the plant, as well as the dikes, will be diverted to the approved erosion control basins. Thus a failure in the primary dike containment system, which is designed for 110% of the stored volume plus precipitation (maximum probable), would result in a controlled spill into the basins where treatment can be applied. In that case, a dike failure in combination with a spill (harmful spills almost always result from a combination of unlikely events) could result in a pollution threat. Such design situations wil receive a thorough pre-construction analysis to minimize the level of risk and to provide additional mechanical safeguards and alarms where warranted.

Detection. Because the plant site will be continuously manned, visual observation will result in the detection of leaks and spills at the earliest possible time. Routine periodic inspection of tanks, valve yards, etc., will be conducted.

Confinement. If at all possible, spills will be prevented from reaching the erosion basins. Neutralization, recovery, etc., is much more efficient if the material involved can be maintained in its original state of concentration. Therefore, the 110% plus precipitation (maximum probable) storage design

9.3 Spill Prevention Control and Counter-Measure Plan

.8 In-Plant Spills (Continued)

criteria is important for confinement. As a final line of defense, large dams in Cottonwood and Sorghum Gulches will be used as barriers for large spills.

For small spills of toxic or hazardous material, temporary containment techniques have been developed by EPA using foam-in-place plastic to build dams and barriers. Dispensing kits for the plastic foam will be located at convenient, well-marked locations throughout the plant. Instructions in their use will be provided for employees in each shift crew.

Cleanup and Disposal. Since no in-plant spills are expected to breach either the diked boundaries or the erosion basins, cleanup will be relatively simple. In most cases, any spilled material can probably be pumped directly from the dike or other containment area back to the original source. If the material is contaminated to such an extent that it must be disposed of, it will be pumped first to a temporary holding tank and then picked up by a commercial waste disposal firm. Similar plans will be prepared and implemented for any other oil or hazardous substance storage areas.

.9 Storm Water Runoff from Disturbed Areas

When sufficient rain water or runoff has collected in a containment or erosion control basin, the surface of the water will be

9.3 Spill Prevention Control and Counter-Measure Plan

.9 Storm Water Runoff from Disturbed Areas (Continued)

visually inspected for any film sheen or discoloration due to the presence of oil. If storm water is contaminated with a hazardous material, the Environmental Protection Coordinator will determine any further action, i.e., separation of oil, neutralization, etc.

.10 Staging Area Spills

Prevention. Loading and unloading procedures will meet the minimum requirements and regulations established by the U.S. Department of Transporation. Warning signs will be prominently displayed in the area, warning of the presence and loading of oil or hazardous material. Tank cars or trucks will have brakes set, motors off, and wheels blocked where possible, and will not be moved at any time during the loading procedure. If any spill or leak occures, all traffic in the area will be stopped immediately.

Detection. Driver, engineers, loaders and others in the area at the time of loading of any oil or hazardous material in the staging area will be required to maintain constant surveillance for any sign of a spill or leakage of any material. Human observation shall be the basis for detection of any spill.

Confinement. Any potential spill of oil or other hazardous material in the staging area is expected to be very small in

9.3 Spill Prevention Control and Counter-Measure Plan

.10 Staging Area Spills (Continued)

quantity. A sloped pad leading to a collection sturcture will be constructed in the staging area, which will hold the maximum capacity of any single compartment of a tank or truck in the area. In addition to foam-in-place containment techniques, the regular spill confinement equipment located at the plant will be used in the case of a spill at the staging area.

Cleanup and Disposal. Equipment and trained personnel located at the plant site to clean up and dispose of oil spills will also be available at all times for use at the staging areas.

.11 Trucking Spills

Prevention. During all loading operations, warning signs or other communication will be prominently displayed. Drivers will be required to set the trucks' brakes, shut off the motor wheels, and get out of the trucks during the loading. Trucks may not be moved until the loading operation is completed and the filling nozzle is removed from the truck and replaced in its rack. All drains and outlets from the trucks will be checked for leakage before, during, and after loading. If a spill or leak is detected, all truck traffic in the area will be stopped immediately.

Detection. Drivers, loaders, and other persons in the loading area will be required to watch for any sign of leakage or

9.3 Spill Prevention Control and Counter-Measure Plan

.11 Trucking Spills (Continued)

spillage. Detection will be assured through constant human surveillance.

Confinement, Cleanup and Disposal. Except for an extraordinary accident, any oil spill from a truck will probably be very small and lcoated exclusively on land. These small spills will be contained and cleaned up with the portable equipment stored at the plant site. In addition, small manmade dikes or diversion ditches can be constructed in areas away from the plant to prevent the spread of a spill. Absorbents could also be utilized to confine and clean up the spill. Disposal would be carried out by loading the oil or contaminated debris and absorbents into trucks for hauling back to the plant disposal site.

Truck-related oil spills are not expected to reach water sources. However, were this to happen, equipment and trained personnel from the plant site would be immediately brought to the area to confine, clean up and dispose of the oil utilizing booms, barriers, separators and absorbents. Chemicals and dispersants would be used only as a last resort.

9.4 Fire Control Plan

The possiblity of accidental fire exists in many of the underground activities. However, reasonable mine design and proper operational safeguards will minimize both the protection for and the consequences

9.4 Fire Control Plan

safeguards will minimize both the protection for and the consequences of this hazard. A comprehensive plan will be developed to identify those sources having potential for causing accidental fires as well as the procedures for preventing and controlling them. Potential sources of underground fires will include fuels and lubricants, equipment electric circuits, explosives, mine supplies, trash, and even the raw oil shale itself.

.1 Potential Fire Sources and Control Methods

Fuels and Lubricants. Diesel fuel, grease, and oil used underground have low volatility and high flash points, making accidental ignition unlikely. Underground storage of diesel fuel will be limited to those quantities consumed on a single operating shift. Storage and fueling operations will occur in specific areas near a return air course. Dry-break systems for fuel and lubricant transfer will minimize spillage. Should a fuel fire occur underground, it would be controlled with the dry chemical extinguishers mounted on all equipment or, if necessary, by a mine fire truck using high pressure fogging nozzles.

Equipment. Mobile diesel-powered equipment, conveyor belts, and the various electric-powered equipment throughout the mine also will be potential fire sources. Appropriate sensing and alarm systems and dry chemical fire suppression systems, in

9.4 Fire Control Plan

.1 Potential Fire Sources and Control Methods (Continued)

addition to the portable dry chemical extinquishers carried on all mobile equipment, will be used for fire control.

Electric Circuits. The various electric circuits extending throughout the mine also will be a potential source of fire. Fire prevention measures will involve use of proper overload circuit breakers and the repair or replacement of damaged insulation.

Explosives. The potential for explosive fires, though remote, is a possibility inasmuch as the AN/FO blasting agent used in mine development is flammable. As discussed before, this material would not be stored in the mine but would be supplied through boreholes from the surface as needed for immediate use. The small amounts of the material in transit from the loading point to the working area would be susceptable to ignition by carelessness or by fire in the transport vehicle. Proper prodecures for such transport and frequent vehicle maintenance would minimize this hazard.

Supplies and Trash. Flammable mine supplies will include small amounts of lumber for concrete forms and bulkheads as well as the packing containers for parts and supplies. Storage, use, and disposal of these materials will be controlled. Trash from underground shops, warehouses, and lunchrooms will be

9.4 Fire Control Plan

.1 Potential Fire Sources and Control Methods (Continued)

disposed of in self-extinguishing containers provided for this purpose. Waste from such containers will be periodically collected and hoisted to the surface for disposal.

Oil Shale. Raw oil shale is a flammable material--the higher its grade, the easier its ignition. Small thin fragments of high grade shale can be ignited with a match to burn slowly with a smoky flame. Spontaneous heating has occured in piles of finely broken high grade shale, and the ignition of a broken shale muck pile by its blasing round has been reported. However, the permeability of the unbroken in-place oil shale is very low, and any fire involving such material would be confined to its exposed surface and would spread only laterally at a very slow rate. Owing to the slow burning characteristics of both the broken and in-place shale and the planned wetting of muck piles after blasting, the possibility of uncontrolled fires will be very remote. Piles of broken shale will not be allowed to accumulate in either the active or inactive workings.

.2 Fire Fighting Procedures

Any indications of a fire will be reported immediately via the central communications system to the fire control coordinator. Upon receiving a report of a possible fire and its location, the fire control condinator will dispatch appropriate fire fighting

9.4 Fire Control Plan

.2 Fire Fighting Procedures (Continued)

equipment. Unless specifically determined to be unnecessary, he will activate the necessary audio, visual, and olfactory systems to initiate evacuation of all but emergency personnel along prescribed and posted escape routes.

Emergency fire fighting equipment will be maintained at several of the shaft level stations and will be manned by specifically assigned and trained personnel. Fire trucks will be equipped to fight fires of all types and will be supported as necessary by the mine water trucks.

Preparedness training will be conducted regularly for all emergency crews. Instructions on fire control and evacuation procedures will be given all new employees. Self rescuers and instruction on evacuation procedures also will be provided for all visitors to the mine.

.3 Surface Fire Protection System

The CB surface facility fire protection system is divided into two distinct types of fire protection. A wet system and a dry system. The wet system may be further subdivided into interior and exterior areas.

The areas interior to buildings are protected by either sprinklers or hose cabinets. The areas to be protected by sprinklers are

9.4 Fire Control Plan

.3 Surface Fire Protection System (Continued)

the shop, the fire station, and the fire water pump house. The interior areas of all other buildings shall be equipped with hose cabinets each with 75 feet of hose and a fog nozzle.

The building exteriors and adjacent areas will be protected with fire hydrants. The fire hydrants shall be spaced such that no point on the site is greater than 250 feet from a hydrant. The hydrants shall be sized such that each hydrant can provide a flow of 500 GPM divided into two streams. Each hydrant will have connections for two 2-1/2 inch fire hoses with one commmon valve.

The fire system will be sized to provide flow for one major fire. The fire water system will flow 2200 GPM (1200 GPM sprinklers and 1000 GPM hydrants) for four hours. The fire water tank will hold a minimum of 550,000 gallons of water.

Areas near the hydrocarbon storage will be provided with monitor nozzles. Some areas of the facility will require a "dry" type of fire protection, such as a Halon system. These areas are those which primarly contain electrical equipment, such as the headframes, substation and computer room. The utility tunnels will be provided with a portable dry type extinguishing system.

9.0 ENVIRONMENTAL CONTROL PLANS

9.5 Waste Management Planning

.1 Introduction

Major oil shale operations will be sources of toxic trace elements and organic chemicals originating from stack emissions, from processing operations, chemicals used in upgrading and gas processing, and associated industrial and municipal wastes. These substances have potential impacts on ecological resources and on human health. The intent of this plan is to identify how these substances will be handled. Many of the mitigative measures involve use of control technology specified by federal and state discharge regulations.

.2 Industrial Wastes

Contaminants will be removed from waste water by chemical, physical, and/or biological treatment. For complex wastes, a series of devices using each of these three principals will be used. In general, the following types of contaminants and removal processes are applicable to the C-b project.

Contaminant	Stream	Process
1) Suspended Solids	Mine Drainage, Retort Condensate, Cooling	Clarification/Filtration (multi-media)
2) Oil and Grease	Retort Condensate, Gas Condensate, Coking Condensate	Gravelly and/or emulsion breaking, air floating coalescing filters
3) Dissolved Inorganics	Mine Drainage, Retort Condensate, Gas Condensate, Cooling Tower Blowdown, Ion-exchange Regenerates	Chemical Oxidation Ion Exchange Reverse Osmosis Adsorption Evaporation

9.5 Waste Management Planning

.2 Industrial Wastes (Continued)

Contaminant	Stream	Process
4) Dissolved Gases	Retort Condensate Gas Condensate Coking Condensate	Skam Stripping
5) Dissolved Organics	Retort Condensate Gas Condensate Coking Condensate Hydrotreating Condensate Mine Drainage	Solvent Extraction Adsorption, Biological Oxidation, Reverse Osmosis, Wet Air Oxidation, (e.g., rotating biological contractors plus carbon adsorption)
6) Trace Elements and Heavy Metals	Retort Condensate Gas Condensate Mine Drainage	Chemical Oxidation Ion Exchange Adsorption
7) Trace Organics	Retort & Gas Condensate Upgrading Condensate Mine Drainage	Reverse Osmosis Adsorption
8) Toxics	Retort, Gas & Upgrading Condensate	Chemical Oxidation Incineration

In particular, the water pollutants which will be controlled to approved levels varies with the source. The following list are the major concerns.

- Gas Condensate - NH_3, H_2S, CO_2, and BOD
- Retort Condensate - NH_3, H_2S, CO_2, and BOD
- Upgrading Condensates - NH_3, H_2S, CO_2, and BOD
- Waste Treatment - Ca/Mg/Na, Chloride, Fluoride, Sulfide
- Mine Drainage - $CO_3^{=}/HCO_3^{-}$, Boron, Ca/Mg/Na, Chloride, Flouride Silica, SO_4

Since the EPA has not generated effluent limitation for BACT or the oil shale industry, the closest applicable standards are for

9.5 Waste Management Planning

.2 Industrial Wastes (Continued)

the petroleum industry. This includes both BACT guidelines and New Source Performance Standards (NSPS). C-b treatment facilities and pollution control devices will be developed to meet the standards of the petroleum industry. All surface storage facilities storing regulated pollutants will be designed to control accidental spills in a confined area. Storage ponds and/or lagoons will be designed to prevent contamination by pollutants of the ground water by use of natural and/or synthetic liners. At the time of decommissioning, these areas will be reclaimed following appropriate capping and/or disposal of the pond sludge. If the material is deemed hazardous, it will be disposed of in a manner to be approved by the EPA or Colorado Water Quality Control Division. Particular attention will also be given to the impact of ongoing public hearings on new Colorado stream classifications and water quality standards. As they have not been promulgated, their impacts are uncertain. Cathedral Bluffs expects to contribute to the hearings governing Piceance Creek Basin as its runoff directly affects a major tributary (White River) of the Colorado River. The salinity standards identified in the Colorado River Basin Compact will directly affect stream standards and classifications for the Piceance Creek Basin.

9.0 ENVIRONMENTAL CONTROL PLANS

9.5 Waste Management Planning

.3 Sanitary Waste

Cathedral Bluffs will provide sanitary waste facilities approved by the Colorado Department of Health - Division of Water Quality. Both chemical and biological treatment will be used in maintaining state standards. Standards used in applying control technology will be primary and secondary drinking water standards.

9.6 Aesthetic or Scenic Resources

.1 Introduction and Scope

A study was undertaken and completed to determine the type and quality of the scenic resources that presently exist in the region sourrounding the C-b Tract as shown in Figure 9.2. The results from this study were then used to define and evaluate areas of visual sensitivity on the tract. The intensive study area for visual sensitivity included the tract and a zone within 6.4 kilometers (4 miles) of the tract boundary as shown in Figure 9.3.

.2 Objectives

The objectives of the study were to characterize the scenic elements of the Piceance Creek basin as they relate to the tract and to the scenic resources of surrounding areas in western Colorado. This information was required to evaluate areas of visual sensitivity in the immediate vicinity of the tract.

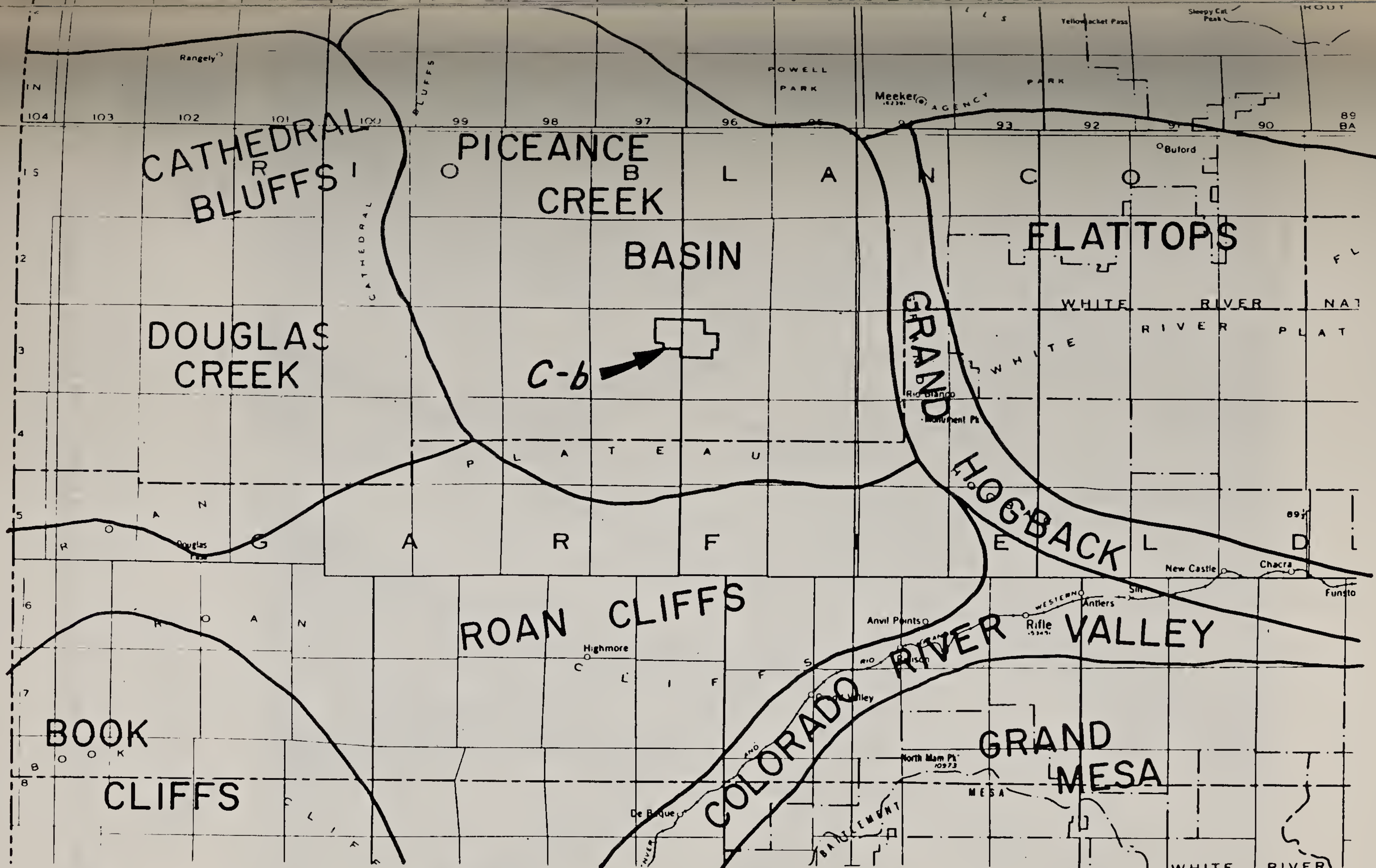


FIGURE 9.2 VISUAL CHARACTER SUB TYPES

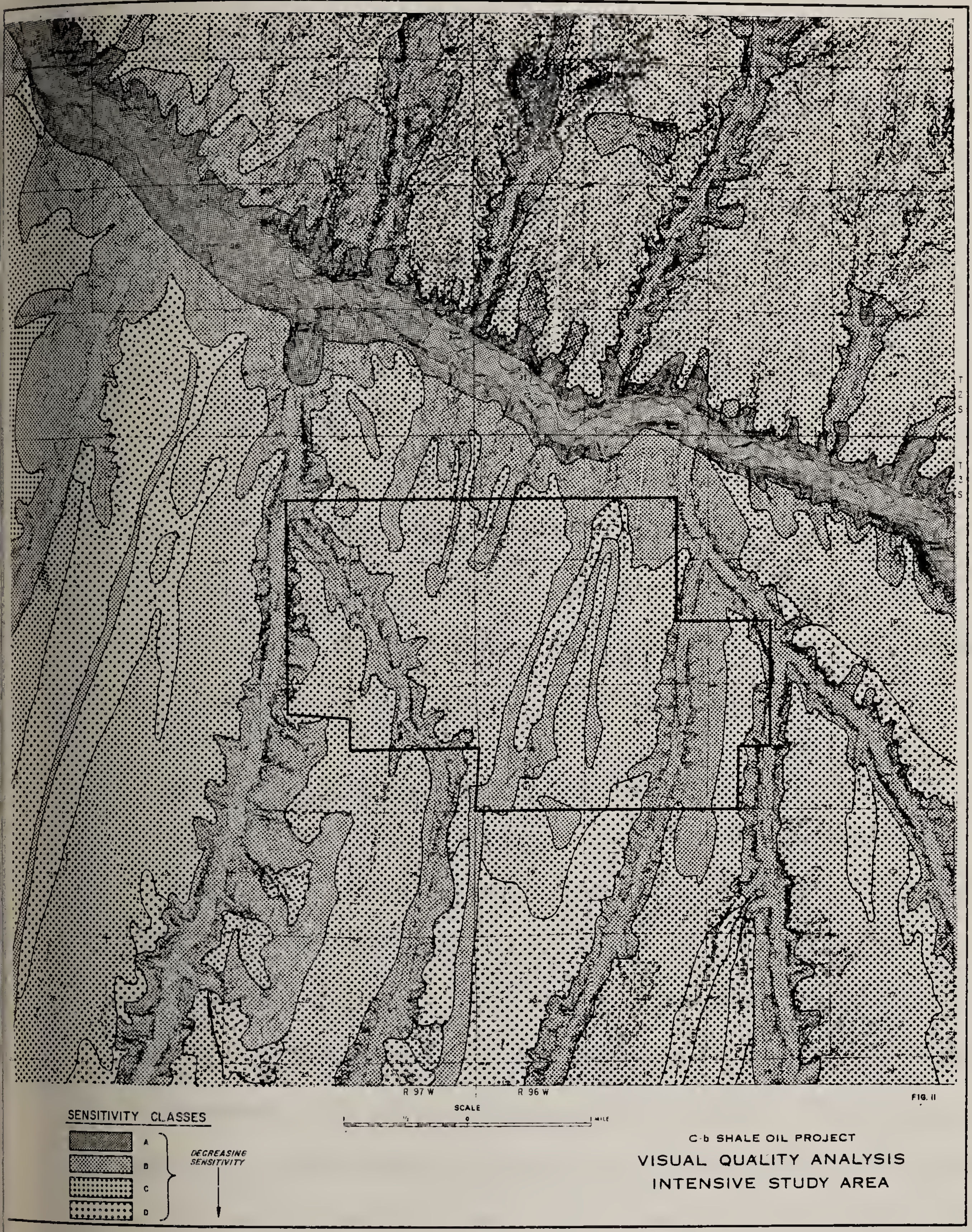


FIGURE 9.3 VISUAL QUALITY ANALYSIS INTENSIVE STUDY AREA

9.0 ENVIRONMENTAL CONTROL PLANS

9.6 Aesthetic or Scenic Resources

.3 Method of Analysis

The method and guidelines used in this study are those used by the U. S. Forest Service in its Visual Management System (USDA Handbook No. 462). A diagram of the method is shown in Figure 9.4. The figure illustrates the sequence of steps that lead to the determination of visual sensitivity levels of the landscape. It should be emphasized that, primarily, this methodology accounts for scenic qualities seen by the majority of basin users. It does not account for small isolated areas that an individual hiker or hunter might encounter when traveling off established travel routes. Such areas are subject to extremely individual preferences that no methodology designed to study regional scenic values can accommodate. Each phase of the technique is discussed as follows.

.4 Method of Analysis - Landscape Factors

Character Type. Visual character type is based on common distiguishing visual characteristics of an area of land. Character type is determined, in this U.S. Forest Service method, by physiographic sections as defined by Fenneman in "Physiography of the Western United States." The Piceance Creek basin is included in Fenneman's Uinta basin physiographic section. The Uinta basin section is approximately bounded on the north by the Uinta Mountains, on the east by the Park Range and on the south by the Bookcliffs. In general the interior of the Uinta basin section is topographically lower than the margins. The interior of the basin is

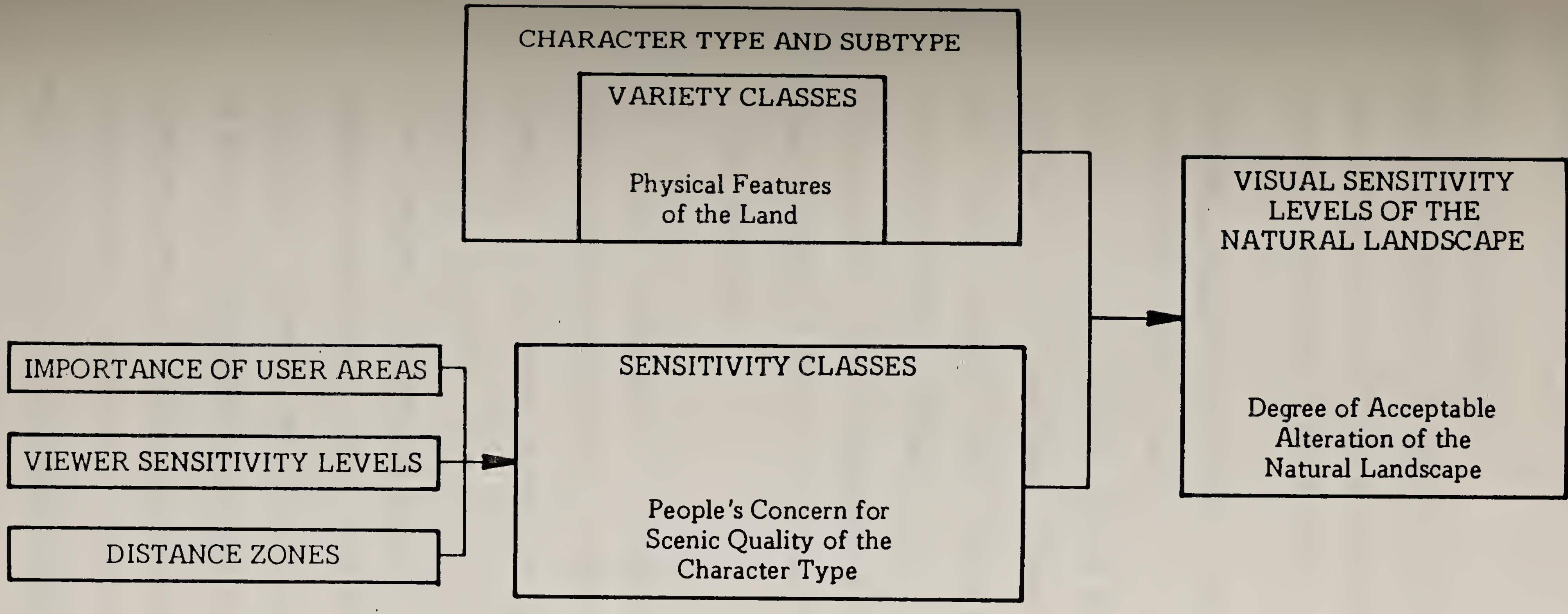


FIGURE 9.4 U.S. FOREST SERVICE VISUAL MANAGEMENT SYSTEM

9.6 Aesthetic or Scenic Resources

.4 Method of Analysis - Landscape Factors (Continued)

characterized by a series of high plateaus which are separated by the major drainages of the region.

Character Subtypes. In order to more effectively describe the landscape types of the region, it is sometimes necessary to define visually distinct subtypes of the character type. Visual subtypes described in this study are: Piceance Creek basin, Bookcliffs, Roan Cliffs, Colorado River Valley, Grand Mesa, Grand Hogback, Colorow Mountains, Flattops, and Cathedral Bluffs-Douglas Creek. The location of these subtypes are shown in Figure 9.1 and described below in terms of form, line, color and texture, the basic components of any landscape.

(1) Piceance Creek Basin - This subtype is characterized by a gently sloping basin which is moderately dissected by parallel drainages. The stream valleys are bordered by walls which vary from steep cliffs to low rolling slopes. Streambeds are generally narrow and most streams are ephemeral. These drainages lead to the Piceance Creek Valley, which is a slightly larger version of its tributaries. Line is smooth and strongly horizontal. Colors are the beige of the eroded sandstone substrate and rock outcroppings, the muted green of sagebrush and darker greens of Pinyon-Juniper and Douglas-Fir vegetation. Valley bottoms range in color from muted sage green to the brighter green of irrigated hay meadows.

9.6 Aesthetic or Scenic Resources

.4 Method of Analysis - Landscape Factors (Continued)

Texture ranges from the very smooth irrigated meadows to coarser rock outcroppings and fairly coarse, mottled, natural vegetation areas.

(2) Bookcliffs - This subtype is characterized by cliffs approximately 2,000 feet high capped with strong horizontal appearing sandstone layers. Steeply eroded, sharp-angled gullies on the cliff faces lead down into gently rolling terrain. The tops of the cliffs form a strong line cutting horizontally across the skyline. The predominant colors of the landscape are the gray of the bottom of the cliffs, which grades into light beige at the top, intermixed with sandy pink and gold-toned horizontal bands. The texture of the cliffs is smooth, as they contain no vegetation. This grades into the fine texture of the sparse vegetation on the lower terrain.

(3) Roan Cliffs - This subtype is characterized by cliffs approximately 3,000 feet high with massive block forms at the top. The cliff faces have highly eroded, long steep slopes which are interspersed with areas of relatively small jutting rocks of strong form. The cliff tops cut into the skyline with rounded, massively blocked lines. The color of the landscape is light gray, with several horizontal reddish bands near the bottom of the cliffs. The texture of the steep, eroded slopes is smooth, interspersed with areas of coarse texture resulting from the occurrence of juniper and Douglas-fir vegetation.

9.6 Aesthetic or Scenic Resources

.4 Method of Analysis - Landscape Factors (Continued)

(4) Colorado River Valley - This subtype is characterized by benchlands formed by the cutting of the river. The river is bordered by tall trees. The lines are strong, low and horizontal. Vegetation colors range from sage green to dark green. Soil color is typically tan or beige. The texture is moderately coarse. The cottonwoods produce a rough texture contrasting with the smoothness of the river.

(5) Grand Mesa - this subtype consists of a flat to very gently rolling mesa top situated at 10,000 feet elevation surrounded by slightly angular foothills with gentle sloping sides. The line is strongly horizontal and is strengthened by a 200-foot to 300-foot escarpment immediately below the mesa top. Colors are primarily the green shades of the vegetation, dominated by the dark green of the evergreens. Texture grades from the smooth, large open spaces of the western portion of the mesa top to the coarse texture of the continuous tree cover of the eastern portion Many lakes are present on the mesa top. The foothills are coarsely textured, due to the heavy evergreen forest cover.

(6) Grand Hogback - This subtype is characterized by strongly upwarped pointed and plate-like strata rimmed by smaller rocks. The line is predominantly from the diagonals of the tilted strata. The vegetation of the mountains (mountain shrub,

.4 Method of Analysis - Landscape Factors (Continued)

pinyon-juniper and Douglas fir) gives a dark green color and course texture interspersed with the banded (reddish, beige, yelowish) color and smoother texture of the exposed rock outcropping.

(7) Colorow Mountains - This subtype has a subdued, very slightly angular mountainous form with a moderate horizontal line. Colors are the dark muted green tones of the vegetation (pinyon-juniper type) and the beige of the rock. Rock covered by a mottled vegetation pattern gives a slightly course texture.

(8) Flat Tops - This subtype is comprised of high, uplifted flat volcanic strata, deeply cut by narrow river valleys. Line is strongly horizontal on the top, becoming steep to moderately angular in the foothills. Colors range from the dark green of the evergreens to the lighter green of aspen and the interspersed grassy parks. This varied vegetation results in a moderately coarse texture.

(9) Cathedral Bluffs - Douglas Creek - This subtype is characterized by rolling, angular low mountain form. Horizontal line predominates in the rock strata of Cathedral Bluffs, with angular line occurring in the other hill areas. Colors are the sage green of the vegetation, alternating with the light beige of the earth. The resulting texture is moderately coarse.

9.6 Aesthetic or Scenic Resources

.4 Method of Analysis - Landscape Factors (Continued)

When compared with most of the other subtypes of the region, it is evident that the Piceance Creek basin is less notable in terms of strength of form and line, and ranks equally with regard to color and texture variations.

Variety Classes. Within the confines of the Piceance Creek basin, there are considerable variations in landform, rockform, vegetation and waterforms. These variations can be defined by a series of variety classes which account for the inherent scenic quality of the landscape. The human aspects will be considered below.

A series of criteria are set forth in Table 9.13 and were used to differentiate the variety classes (distinctive, common or minimal) which exist in the Piceance Creek basin. It was convenient to identify the distinctive and minimal areas on a map and to assume the remainder are common. Examples of these variety classes are shown in Figures 9.5 through 9.8, and a map of variety classes is shown in Figure 9.9. The cliffs at the mouth of Scandard Gulch are the only distinctive area found on the tract. Several other distinctive areas are located off-tract; most of these also consist of dominant rockforms. The minimal areas in the study area are quite extensive and cover a considerable portion of the tract and nearby areas to

	DISTINCTIVE	COMMON	MINIMAL
ANDFORM	Cliffs on valley sides Highly eroded slopes	Moderately steep valley sides, flat ridge tops and flat valley bottoms	Extensive flat ridge tops or valley floors
OCKFORM	Rock features which stand out on landform Unusual rock strata exposures	Rock features obvious but do not stand out	Rock features small to nonexistent
EGETATION	High degree of patterns in vegetation High diversity in plant forms Relatively large stands of trees	Continuous vegetative cover with some degree of pattern Low diversity in plant forms Irrigated meadows	Continuous vegetative cover with little or no pattern Chained or sprayed areas Non-irrigated valley bottoms
AKES, ONDS	Irregular shorelines Greater than one acre in size	Regular shorelines Less than one acre in size	No lakes or ponds
REAMS, RINGS AND EPS	Springs and seeps which form ponds Perennial streams Large volume	Springs and seeps which do not form ponds Ephemeral streams Low volume	No streams, springs or seeps

nly one of the criteria had to be met for an area to be classed as Distinctive, whereas two or three criteria ad to be met for an area to be classed as Minimal. This allowed Distinctive areas to be readily identified hile Minimal areas needed considerably more factors for them to be so classified.

TABLE 9.13 VARIETY CLASSES DETERMINATION

FIGURE 9.5 MINIMAL VEGETATION AND LANDFORM

GURE 9.6 COMMON LANDFORM AND DISTINCTIVE WATERFORM

FIGURE 9.7 DISTINCTIVE ROCKFORM

FIGURE 9.8 COMMON VEGETATION

FIGURE 9.9 VISUAL QUALITY ANALYSIS VARIETY CLASSES

.4 Method of Analysis - Landscape Factors (Continued)

the west. These areas have been chained within the past 10 years.

.5 Method of Analysis - Human Factors

In order to account for the human aspects of the visual experience in this scenic quality analysis, the methodology includes a measurement of the relative importance of use areas, water bodies and travel routes, viewers' concern for scenic values, and the distance from which the landscape is viewed. The rationale used to account for each of these factors will be discussed below.

Importance of User Areas. User areas such as roads, trails, overlooks, camp sites, ranch headquarters, cow camps, ponds and streams are rated as being of primary or secondary importance based on size, volume of use, duration of use, recreational use and local importance. In this study, user importance was considered only in terms of use factors within the Piceance Creek basin. These factors are shown in Table 9.14. A map of primary and secondary user areas identified in the study area is shown in Figure 9.10. User volume, duration of use, and size were the criteria used to differentiate user areas.

The only travel routes rated as being of primary importance were the Piceance Creek road and the Collins Gulch road.

	PRIMARY IMPORTANCE	SECONDARY IMPORTANCE
TRAVEL ROUTES Roads Trails	High use volume Major access road Long use duration	Low use volume Project road Short use duration
USE AREAS Overlooks Camp areas Ranch headquarters Cow camps	Large size Long use duration High use volume	Small size Short use duration Low use volume
WATER BODIES Ponds Streams	High recreation use	Low recreation use

TABLE 9.14 USER AREA CRITERIA

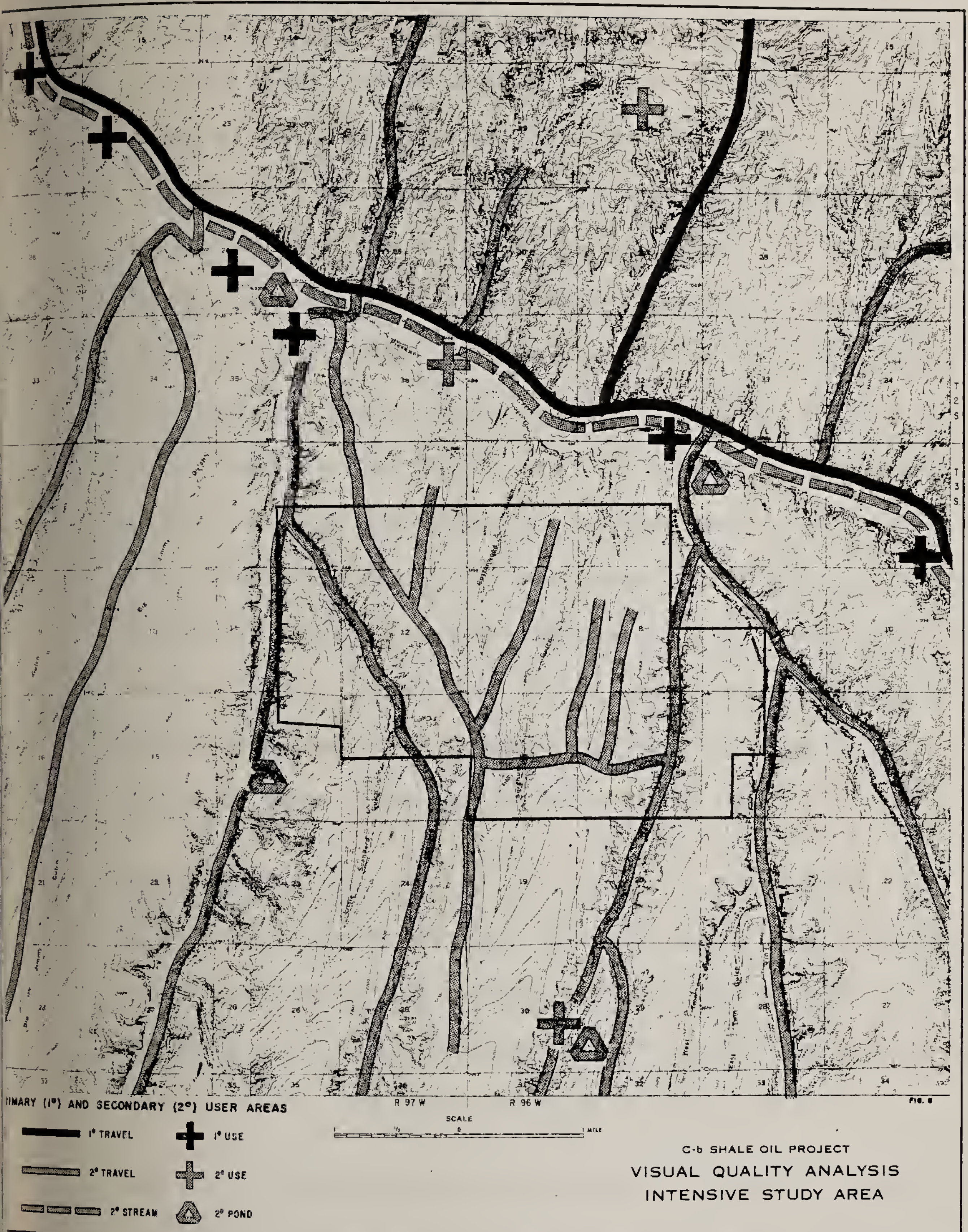


FIGURE 9.10 VISUAL QUALITY ANALYSIS USER AREAS

9.6 Aesthetic or Scenic Resources

.5 Method of Analysis - Human Factors (Continued)

Piceance Creek road is used by local residents, drilling crews and government agency personnel. It is not a scenic highway; in fact, until it was completely paved several years ago, it did not appear on many highway maps. Collins Gulch road serves the employees of a gas absorption plant located north of Tract C-b. All other roads were classed as being of secondary importance due to the lesser traffic volumes and seasonal use. These roads are used primarily by local ranchers for movement of cattle and sheep and by hunters seeking deer and elk, and for oil and gas exploration and development. User areas of primary importance are the rance headquarters, all of which are situated on the Piceance Creek road. All other use areas and water bodies were classed as secondary in importance due to the low volume of general use and low recreational use.

Viewer Sensitivity Levels. To account for the concern for scenic values which the users of the Piceance Creek basin have, a matrix was developed showing the importance of user areas and an appraisal of the percentage of users having some concern for scenic values. The matrix is shown in Table 9.15.

The U. S. Forest Service method bases it concern for scenic values on a percentage of viewers having a major concern for scenic values. The U. S. Forest Service assumes that persons

ser rea	Viewer Sensitivity Levels		
	1	2	3
ary	At least 1/4 of users have SOME concern for scenic values (PICEANCE CREEK ROAD AND RANCH HEADQUARTERS)	Less than 1/4 of users have SOME concern for scenic values (COLLINS GULCH ROAD)	
ndary	More than 3/4 of users have SOME concern for scenic values.	Between 3/4 and 1/4 of users have SOME concern for scenic values (ALL OTHER INTENSIVE STUDY AREA ROADS)	Less than 1/4 of users have SOME concern for scenic values (AREAS NOT SEEN FROM ANY USER AREA)

TABLE 9.15 VIEWER SENSITIVITY LEVELS

9.6 Aesthetic or Scenic Resources

.5 Method of Analysis - Human Factors (Continued)

having a major concern for scenic values are those engaged in driving for pleasure, hiking scenic trails, camping at primary use areas, or using lakes and streams for other recreational activities. Minor concern for scenic values is assumed to be held by persons involved in daily commuter driving or hauling forest products or employed in other commercial uses of the forest. On this basis less than 10 percent of all Piceance Creek basin users are estimated to have a major concern for scenic values. Given this assumption there are no primary sensitivity levels. Since no hard data was available on which to base this 10 percent estimate, a liberal approach was taken by assuming that users had some concern for scenic values. This permitted all sensitivity levels to be represented.

The Piceance Creek road and the ranch headquarters were placed in sensitivity Level 1. It was assumed that at least 25 percent of these users had some concern for scenic values. Collins Gulch road was judged to have fewer users concerned about scenic values and thus was placed in sensitivity Level 2. All other roads in the study area were also placed in sensitivity Level 2. While they are of secondary importance, a considerable number of users (deer hunters and local ranchers) were assumed to have some concern for scenic values while engaged in their primary

goals. All areas not seen from any travel route or use area were placed in sensitivity Level 3, the lowest level.

Distance Zones. One method of determining how different sections of the study area are viewed by users is to define distance zones, view the landscape from each user area, and prepare a distance zone map for each user area. The criteria used in defining each distance zone is shown on Table 9.16. In conjunction with the distance zone mapping, sensitivity levels were determined for each area. All distance zone maps were overlayed and sensitivity levels were used to set priorities in developing the composite distance zone/sensitivity level map shown in Figure 9.11. In all cases the most restrictive sensitivity level was used in the composite map.

Sensitivity Classes. The final step in depicting the sensitivity classes which exist on the tract is to overlay the variety class map with the distance zone/sensitivity level map. The U.S. Forest Service method is designed to produce a final map showing quality objectives and recommending management methods to acocmplish these objectives. In this study, the quality objectives have been changed to sensitivity classes as shown in Table 9.17. A matrix developed by the U. S. Forest Service was used to arrive at the sensitivity class map. This matrix is

	Foreground	Midground	Background
miles)	0 to 1/4-1/2	1/4-1/2 to 3-5	3-5 miles to infinity
city	Detail		No detail
wed (example)	Rock point	Entire ridge	System of ridges
racteristics	Individual plants and species	Texture and Form (conifers/ hardwoods)	Patterns (light and dark)

TABLE 9.16 DISTANCE ZONE CRITERIA

FIGURE 9.11 VISUAL QUALITY ANALYSIS DISTANCE ZONES/SENSITIVITY LEVELS

Class	USFS Visual Quality Objective	Degree of Acceptable Change
	Retention	Should not be evident
	Partial Retention	Should be visually subordinate
	Modification	May be visually dominant but must possess visual characteristics of natural landscape.
	Maximum Modification	May be visually dominant but must possess visual characteristics of natural landscape when viewed as background.

TABLE 9.17 SENSITIVE AREAS - QUALITY OBJECTIVES COMPARISON

9.6 Aesthetic or Scenic Resources

.5 Method of Analysis - Human Factors (Continued)

shown in Table 9.18. The map of sensitivity classes illustrated in Figure 9.12 depicts the baseline scenic quality of the intensive study area. Guidelines for visual management of these sensitivity classes are discussed below.

.6 Visual Management Guidelines

The U. S. Forest Service has developed management guidelines for retaining the scenic quality of lands under its control. The CB Shale Oil Project will use these same visual management guidelines in all planning, construction, reclamation and mining operations. Planned activity on the tract will not affect areas of high visual sensitivity. In the event that development activities must take place in areas of high visual sensitivity, these activities will be designed to minimize the visual impact of the activity. The level of visual sensitivity of each area proposed for development will be one of several criteria (ecological, economic, hydrological, meteorological, etc.) used in planning and construction of tract activites. The level of visual sensitivity of the affected area will be a factor in determining design modifications necessary to minimize visual impact.

The visual management guidelines for each sensitivity class are given below:

Variety Class	Distance Zone/Viewer Sensitivity Level						
	Foreground, level 1	Midground, level 1	Background, level 1	Foreground, level 2	Midground, level 2	Background; level 2	Not Seen level 3
Distinctive	A	A	A	B	B	B	B
Common	A	B	B	B	C	C	D
Minimal	B	B	C	C	C	D	D

* Sensitivity Classes

A
B $\downarrow$ Decreasing Sensitivity
C
D

TABLE 9.18 SENSITIVITY CLASS MATRIX*

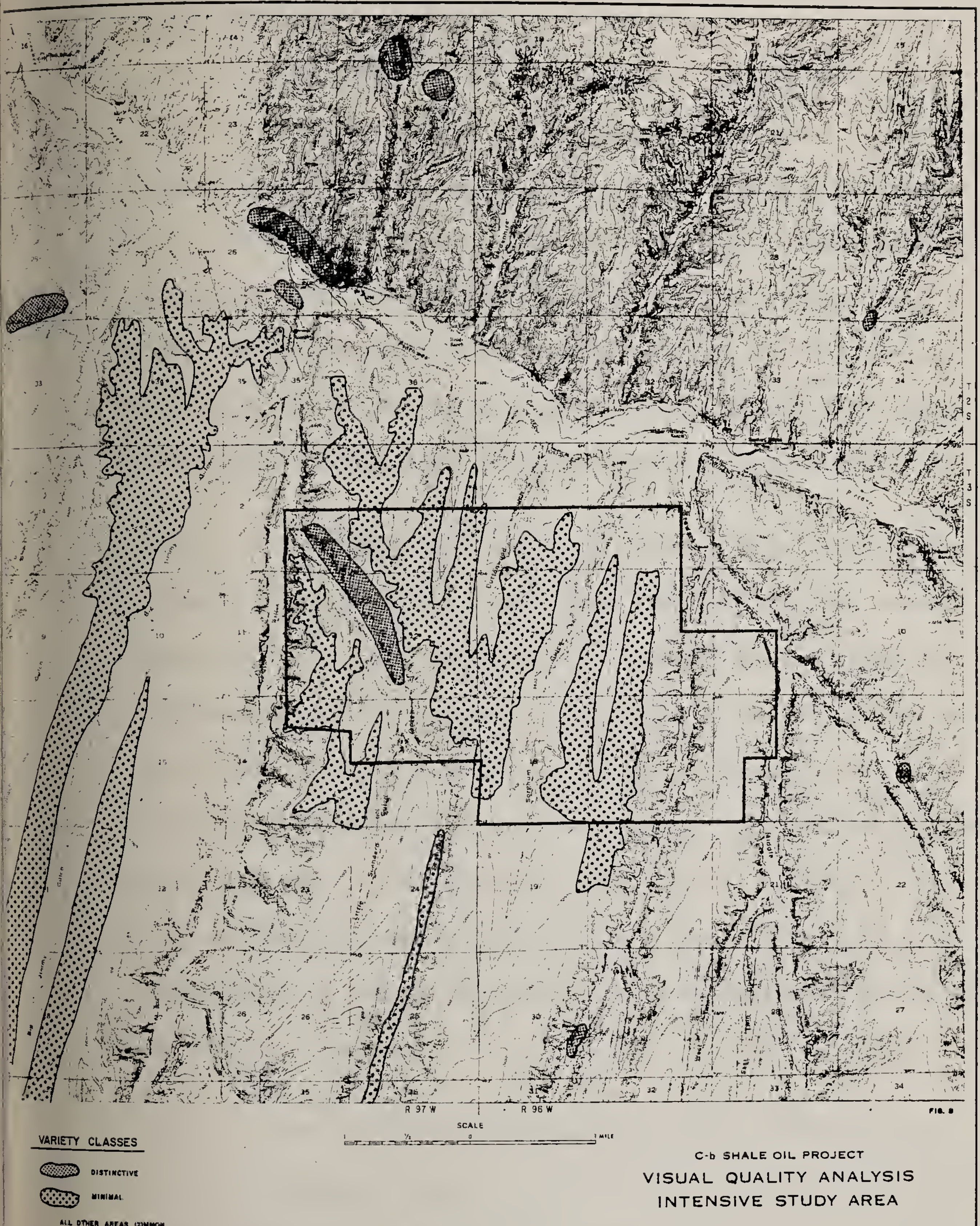


FIGURE 9.12 VISUAL QUALITY ANALYSIS SENSITIVITY CLASSES

9.0 ENVIRONMENTAL CONTROL PLANS

9.6 Aesthetic or Scenic Resources

.6 Visual Management Guildelines (Continued)

Class A - Develpoment activities may only repeat form, line, color and texture which are frequently found in the landscape. Changes in their size, amount, intensity, direction, patterns, etc., should not be evident. Reducton in form, line, color and texture contrast due to development should be accomplished either during construction or immediately thereafter by such means as seeding vegetation clearings and cut-and-fill slopes, hand planting large plant stock, or painting structures.

Class B - Development activities may repeat form, line, color or texture common to the landscape. Changes in size, amount, intensity, direction, pattern, etc., should remain visually subordinate to the landscape. Activities also introduce form, line, color or texture which are found infrequently or not at all in the landscape, but they should remain subordinate to the visual strength of the landscape. Reduction in form, line, color and texture contrast due to development should be accomplished as soon after construction as possible, but no more than one year later.

Class C - Development activities may visually dominate the original landscape; however, activities of vegetative and land form alteration must borrow from naturally established form, line, color and texture so completely and at such a scale that

9.6 Aesthetic or Scenic Resources

.6 Visual Management Guildelines (Continued)

visual characteristics are those of the natural landscape. Additional parts of these activities such as structures and roads must remain visually subordinate to the proposed composition. Activities which involve the introduction of facilities such as buildings, signs, roads, etc., should borrow from the existing forms, line, color and texture so completely and at such a scale that the visual character is compatible with the natural landscape. Reduction in form, line, color and texture contrast due to development should be accomplished in the first year or at a minimum should meet existing regional guidelines.

Class D - Development activities may dominate the landscape; however, when viewed as background, the visual characteristics must be those of the natural landscape. When viewed as foreground or middle ground, they need not borrow from the natural form, line, color and texture. Alternations may also be out of scale or contain incongruent detail when viewed as foreground or middle ground. Introduction of additional parts of these activities such as structures and roads should remain visually subordinate when viewed as background. Reduction of contrast in form, line, color and texture due to development should be accomplished within five years.

9.6 Aesthetic or Scenic Resources

.7 Conclusions

The Piceance Creek basin was found to have low scenic value when compared to the other landscape types of the region. It contains marginal strength of form and line when compared to such areas as the Bookcliffs, Roan Cliffs, Grand Mesa and the Flat Tops. It rates about equally with these with regard to color and texture. On a regional basis the Piceance Creek basin has an extremely low visual character.

The scenic values of the Piceance Creek basin were evaluated solely within the context of the basin itself. A four level ratng scale was developed based on the U. S. Forest Service Visual Management System. Within the context of the Piceance Creek basin proper, the only Class A area near Tract C-b is the Piceance Creek road corridor. The tract is located in an area determined to be of sensitivity Classes B and C. The sensitivity Class B areas include the principal drainage cutting through the tract. The Class C areas comprise the chained regions, which cover some 50 percent of the tract. The bottom of the on-tract portion of Sorghum Gulch was rated as Class D since it is not visible from any user area.

The assumptions made in this study were designed to maximize the scenic values which do exist in the Piceance Creek basin. As stated earlier, these values are marginal when compared

9.6 Aesthetic or Scenic Resources

.7 Conclusions (Continued)

to those existing in contingruous areas of Western Colorado.

The final map is a liberal interpretation of the Piceance Creek basin's scenic values, since most users' cone-of-vision does not expose them to many of the side gulches which contain the basin's distinctive landscapes. This was most evident to the field investigators who has considerable familiarity with the area but still found access to must of it solely as a result of doing this study.

9.7 Archeological, Historic or Scientific Values

.1 Introduction and Scope

The environmental setting of the Piceance Creek basin is discussed in detail in the preceding sections of this document. The setting indicates that some elements of the region would have encouraged at least seasonal use of the area in the past. Surface water is available throughout the year in stream valleys and raw materials, with the exception of stone tool materials, are readily available. Generally, the Piceance Creek basin is similar to other parts of the Colorado plateaus, which have had a lengthy history of human occupation.

A detailed baseline study of the cultural resources of Tract C-b has been conducted under the direction of C. H. Jennings of the Laboratory of Public Archaeology at Colorado State University.

9.0 ENVIRONMENTAL CONTROL PLANS

9.7 Archaeological, Historic or Scientific Values

.1 Introduction and Scope (Continued)

Previous archaeological work in the Piceance Creek basin, including a reconnaissance of the tract, was carried out by Colorado State University in cooperation with Thorne Ecological Institute of Boulder, Colorado during the summer of 1973. That work was done as part of the Regional Oil Shale Study for the Colorado Department of Natural Resources (ROSS #5). In addition, other field work in the Piceance Creek basin has been carried out by the University of Denver and Southern Colorado State College in connection with other oil shale projects.

A majority of the detailed field work on Tract C-b was conducted in August 1974. A total of 2,640 acres was intensively examined. Examination of drill sites and other potential disturbed areas that were not included in the initial studies have been conducted since then. Field work was conducted under Federal Antiquities Permit 70-CP-055.

The objectives of the investigation of cultural resources in the C-b Tract vicinity were to identify sites of past human activity in the area, to relate these sites to contemporaneous activities in the region, and to assess the scientific value and historical significance of each site.

A quadrat system of quarters of public land survey sections was used for the detailed field survey of the tract. The quadrats

9.7 Archaeological, Historic or Scientific Values

.1 Introduction and Scope (Continued)

were laid out in a checkerboard pattern and each sample quadrat was examined by three or four investigators making a series of sweeps. All sites encountered were recorded on Archaeological Survey site inventory forms and these have been included in the Data Reports to the OSO. None of the sites had enough artifacts to warrant any attempt at systematization of standardization. All the artifacts were catalogued in the Colorado State University system and are stored at Colorado State University. The OSO is aware of the areas surveyed and sites identified.

Prior to this study, it was believed that the Piceance Creek basin did not have any paleontological resources. However, geological workers discovered mammalian fossils at two sites in the vicinity of Tract C-b. Dr. Peter Robinson, Director of the University of Colorado Museum, has reported that one of the fossils is an as-yet-unidentified mammal and the other apparently the head of a femur of an Uintathere, probably *Uintatherium*. The sites are known to the OSO.

.2 Synopsis of Region's Cultures

Paleoindian Period, Prior to 7000 B.C. There is known evidence of Paleoindian occupation in the tract region. The absence of evidence of either proboscideons or bison in the Piceance Creek basin's fossil record may indicate that the resources which

9.7 Archaeological, Historic or Scientific Values

.2 Synopsis of Region's Cultures (Continued)

would have attracted Paleoindians were either not present or not present in large enough numbers to have met the hunter's subsistence requirements.

Archaic Period, 7000 B.C. - 1776 A.D. The earliest human occupation of the Piceance Creek basin dates from 7000 B.C., and the intensity of occupation increased steadily over the next several thousand years. The basin would have been ideal for people pursuing an Archaic mode of subsistence. A wide variety of plant and animal resources would have proved attractive.

In neighboring regions, a mixed horticultural and foraging subsistence system, termed the Fremont Culture, was practiced. None of the horticulatural practices, pottery or art, is evident in the Piceance Creek basin. Thus, it seems probable there was no permanent occupation of the basin. Cool to cold soils and short growing seasons are the principal restrictive factors; therefore, corn cultivation would have been a highly unreliable source of subsistence. The Fremont people may have to come into the region in search of game and wild vegetable products, but their presence would not be separable from that of other contemporaneous groups using the region for the same purpose.

Protohistoric Period, 1776 A.D. - 1868 A.D. The Escalante-Dominquez expedition gives the first evidence of use of the

.0 ENVIRONMENTAL CONTROL PLANS

.7 Archaeological, Historic or Scientific Values

.2 Synopsis of Region's Cultures (Continued)

region surrounding the tract by an ethnographically known group, the Ute Indians. Escalante, however, gives no information on the way of life of the Northern Utes.

In the Piceance Creek basin, several sites have been located which may be the remains of the Ute occupation of the region. All have produced preindustrial artifactual material, but no metal or other goods which would indicate contact with Euro-Americans. Sites on or near the tract are either definitely tied to the Euro-American occupation of the area, or have no clear ethnographic relationships.

Euro-American Period, 1868 A.D. - Present. The American Indian occupants of the region were the Ute Indians, who remained there until forcibly removed in 1879. Upon expulsion of the Utes, Euro-American settlers began to occupy the area. Early settlers raised sheep and cattle in the basin, and the subsequent over-grazing had considerable effect on the landscape.

.3 Cultural Resources - Preshistoric Sites

Four prehistoric archaeological sites have been recorded on the tract and in immediately adjacent areas; these sites are known the OSO. The tract has been intensively examined for antiquities, but in the adjacent areas site discovery has been the result of chance encounters rather than systematic survey. Photographs of

).7 Archaeological, Historic or Scientific Values

.3 Cultural Resources - Prehistoric Sites (Continued)

artifacts discovered at recorded sites, as well as photos of isolated finds, are shown in Figure 9.13, and Figure 9.14. The recorded sites are as follows:

Site 5RB69. This site is known to the OSO. It faces north, 27 meters above the flood plain of Piceance Creek, and is relatively distant from the bluffs. The area has been disturbed to a depth of 5 centimeters by livestock walking over the site, but there is no evidence to indicate the presence of any stationary objects such as fire pits, housefloors or storage structures. There is a good possibilty that local residents have collected at least some of the artifactual material from the surface.

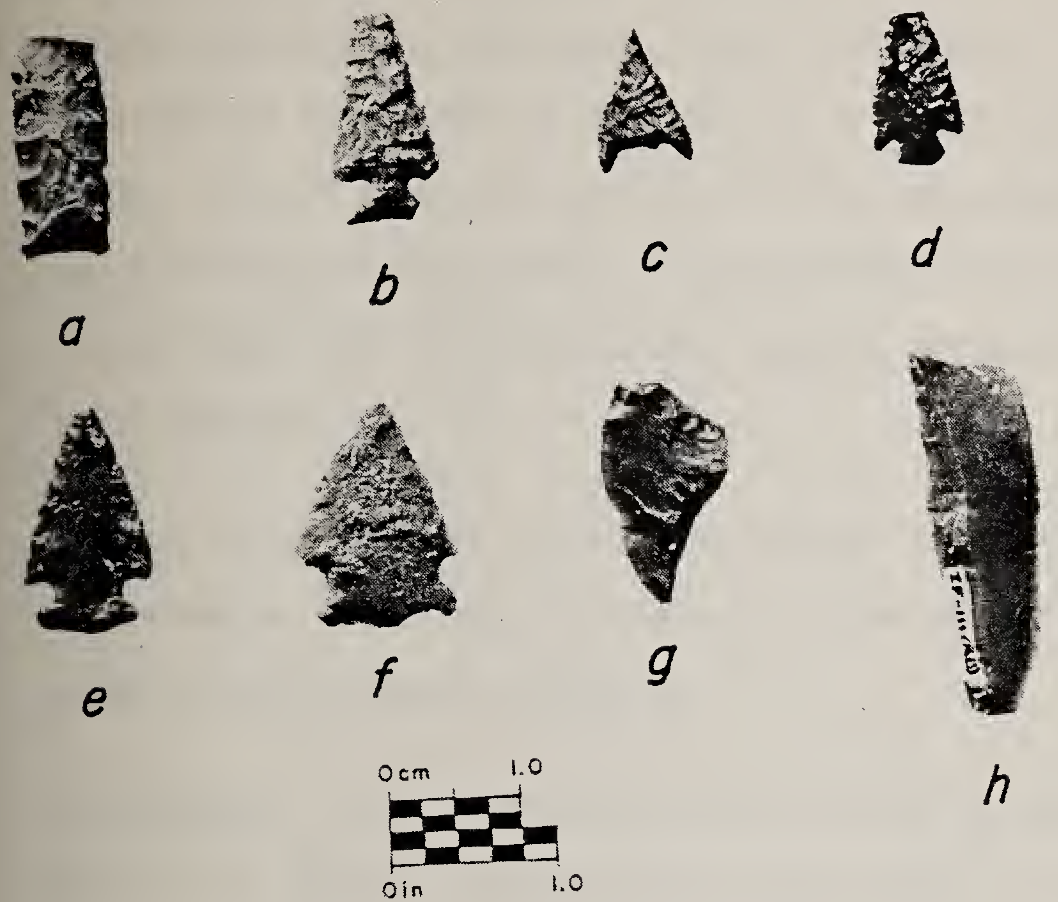
Six flakes comprise the total artifact yield on the site. The yield is too limited to permit any assignment of the site to a time period other than Protohistoric or earlier.

Site 5RB136. The site is on the crest of the ridge between Setwart Gulch and Sorghum Gulch; the precise location is known to the OSO. The site is on a fairly level ground and elevated above the sorrounding terrain. It is located in a dense stand of pinyon-juniper.

There are no visible features present on the site even though the site is relatively undisturbed. However, a few fragments

a. Artifact No. IF114
b. Artifact No. IF115
c. Artifact No. IF116
d. Artifact No. IF118

FIGURE 9.13 CORE AND HAND STONES FROM TRACT C-b



a. Artifact No. 5RB136.1
b. Artifact No. 5RB146.1
c. Artifact No. 5RB146.3
d. Artifact No. IF109
e. Artifact No. IF112
f. Artifact No. IF113
g. Artifact No. IF110
h. Artifact No. IF111

FIGURE 9.14 SMALL CHIPPED STONE ARTIFACTS FROM TRACT C-b

of shattered bone which had been exposed to intense heating were found. The artifact yield was small. Only seven waste flakes and a single tool were found. The tool (5RB136.1) is a bifacially flaked object with no modifications, such as notches, of the blade margins.

The absence of diagnostic artifacts from the inventory makes determination of the age of occupation or the cultural affinities of the occupants impossible.

Site 5RB146: The site occupies about the same topographic position as 5RB136. The exception is that there is a tributary drainage to Stewart gulch which has incised itself into the eastern flank of the ridge.

The site has been extensively disturbed by the chaining of the ridge tops, and its scientific and cultural values have been destroyed. Only three waste flakes could be found in the area, indicating rather limited use of the site. Two projectile points (5RB146.1 and 5RB146.3) were found. They are similar to others found in the region. One projectile point is slightly asymmetrical; one blade margin is straight, while the other is convex. No dates were assigned to this type. A single scraper fragment was also found at the site. The site is assigned to the Archaic Period and falls near the middle of the period.

.7 Archaeological, Historic or Scientific Values

.3 Cultural Resources - Prehistoric Sites (Continued)

Site 5RB147. The site is in a ridge-top situation and has a good view of Scandard Gulch and the tract area to the east; OSO is aware of the precise location. Because this area has been subjected to chaining, much of the site has been extensively disturbed. The site produced four waste flakes and a small fragment of knife blade or projectile point. The tool is too fragmentary to be compared with materials from other sites.

.4 Cultural Resources - Euro-American Sites

Site 5RB67 is located on an alluvial fan across the bottom of Middle Fork Stewart Gulch, OSO is aware of the site. It consists of a cement-chinked log cabin, a dugout and a thin scatter of historic trash. An abandoned irrigation ditch also crosses the site.

The cabin is in a bad state of repair, though there are no signs of disturbance of the deposits. Materials collected include beer cans dated from the late 1940's and early 1950's, as well as pottery and glass shard. The last significant use of the site appears to have been 25 years ago. Nails used indicate the cabin was probably built no earlier than the 1920's.

.5 Isolated Finds

Projectile Points. Three projectile points (IF109, 112 and 113) collected from the tract area could not be associated with any

.7 Archaeological, Historic or Scientific Values

.5 Isolated Finds (Continued)

other artifact materials. These artifacts were probably lost or discarded at the places where discovered.

Other Chipped-stone Tools. A simple flake (IF110) was found that has been retouched for a short distance along one margin. It probably served as a knife rather than scraper.

One tool which was found is relatively rare in the Piceance Creek basin. It is a combination tool that has an acutely retouched working edge along one of tis longer edges and a very steeply retouched working edge on one of the shorter edges. The tool (IF111) is a combination side-and-end scraper which also has an intentionally produced graver tip.

A core (IF114) was found from which flakes, for manufacture into tools, were removed. The sharp edge formed where the scars meet shows no evidence of wear. This would indicate that the specimen had not been used for another function. The object is not suitable for dating.

Another very small fragment of a bifacially chipped tool was found but it was too small to identify.

Ground Stone Tools. A subrectangular mano, or hand stone (IF115) used in the processing of nuts and seeds into meal, was

7 Archaeological, Historic or Scientific Values

.5 Isolated Finds (Continued)

found. It is made of quartzite cobble, has two working faces, and is about the proper size for one-handed use.

Another mano (IF116) has only one working face.

Another tool (IF118) is a small water-worn cobble of some dense, fine-grained, black material. It shows no manufacturing or use marks, but does have prominent flattened areas or facets on the two faces. It has no features of note and has no diagnostic value.

.6 Summary and Conclusions

Four prehistoric sites (three within the tract and one outside), one historic site outside the tract boundary, and several isolated artifacts comprise the cultural resources found on the tract.

The time period represented by the sites and artifacts falls roughly between 5000 B.C. and the early 1950's. This spans the Archaic and Euro-American periods. The area was first used by hunter/gatherers and then by pastoralists who raised sheep and cattle. From the foregoing information, it is assumed that the tract was only lightly occupied. The chaining of the pinyon pine-juniper probably had deleterious effects on the fragile archaeological sites and evidence of prehistory activity was possibly destroyed by that range improvement program.

.7 Archaeological, Historic or Scientific Values

.6 Summary and Conclusions (Continued)

No factor in the cultural resource inventory has been found which would prevent further development of the mineral resources on the tract, according to the investigating archaeologist's report.

In summary, sites 5RB136 and 5RB146 are the only sites deemed worthy of future consideration in the development of Tract C-b. These sites will be further investigated prior to any developments which would disturb them. The other recorded sites in and near the tract will require no further study as they either have very little potential or have already been destroyed by human or natural factors.

8 Noise Plan

.1 Introduction

As a growing part of the concern for the environment, increasing attention is being paid to occupational noise and noise-related impacts to the environs of an impact area. Occupational noise levels are prescribed by OSHA and MSHA, however little is known on the exact impact of noise to wildlife and low level noise to human behavior. Cathedral Bluffs has and will continue to meet OSHA and MSHA requirements in the personnel working areas.

Noise Plan

.2 Occupational Noise

The major areas of concentrated noise are:

- processed shale transportation systems;
- oil shale preparation facilities (crushers and screens);
- surface retorting facilities;
- blasting; and
- transportation of secondary products necessary to operate the facility.

Working areas in each of these impacted areas will be designated as low, medium, and high noise levels based on noise surveys conducted in these areas and past industrial noise level measurements taken at similar operations (e.g., Logan Wash). Each of these designated areas will employ recent noise determinant technology sufficient to assure levels which meet federal and state standards. Generally, noise level control technology is built into equipment. Additional needs may require the use of noise dissipators or use of coverings. The following programs will be incorporated to minimize the impacts of noise.

- Measure existing background noise prior to construction.
- Specify equipment with built-in noise reduction technology.
- Perform monthly noise surveys to determine worker noise exposure and compare to OSHA and MSHA long- and short-term human exposure. If levels are too high, noise reduction to acceptable levels will be implemented.

Noise Plan

.2 Occupational Noise (Continued)

- Maintan existing noise control technology to specifications and, where appropriate, adapt equipment which does not meet specified noise levels.
- In areas where noise levels do not meet OSHA or MSHA requirements, CB will provide and require those individuals to use devices to prevent any short- or long-term exposure to unacceptable high noise levels.

.3 Environmental Effects

Data on the effects of noise on wildlife is minimal and highly controversial. However, noise levels associated with the C-b operation will be attenuated to levels of approved background at a distance of one mile from the noise source. This will include the placement of noise associated activities in a location where the noise generated can be reflected and absorbed by natural barriers. Furthermore, conveyor belts will be constructed to provide shield for both dust and noise at transfer points to prevent abnormally high levels. All muffler systems of trucks will be inspected to ensure their original specification regarding noise levels. In addition, periodic noise-related activities will be scheduled at times which have the minimal impact to wildlife such as deer.

Routine monthly noise monitoring will be performed to ensure the safety of workers. Furthermore, every attempt will be made to attenuate noise levels to the environs of the site to a level approaching background at one mile from the noise center.

ENVIRONMENTAL CONTROL PLANS

Fish and Wildlife Plan

This plan delineates habitat losses which will occur and mitigation efforts to replace in kind or to improve alternative habitat for selected species of animals. This plan is a dynamic document, which will be updated and revised as new management direction and information become available. Because this plan was developed in cooperation with the Department of Wildlife, BLM and OSO, any revisions will be developed cooperatively and in coordination with the Regional Piceance Basin Habitat Management Plan, with final approval of the OSO.

.1 Summary of Lease Requirements

Section 4 of the Stipulations requires that the Lessee submit a fish and wildlife management plan for the following purposes:

- to meet the requirements of Stipulations which state that "the Lessee shall submit ...a detailed fish and wildlife management plan which shall include the steps which the Lessee shall take to: 1) avoid or, where avoidance is impracticable, minimize damage to fish and wildlife habitat, including water supplies; 2) restore such habitat in the event it is unavoidably destroyed or damaged; 3) provide alternate habitats; and 4) provide controlled access to the public for enjoyment of the wildlife resources on such lands as may be mutually agreed upon. The plan shall include, but not be limited to, detailed information on activities, time

Fish and Wildlife Plan

.1 Summary of Lease Requirements (Continued)

schedules, performance standards, proposed accomplishments, and ways and means of avoiding or minimizing environmental impacts on fish and wildlife.

- to provide information necessary to satisfy requirements of the Stipulations concerning mitigation of damage to fish or wildlife habitat, which includes the formulation of measures to "avoid, or, where avoidance is impracticable, minimize and repair injury or destruction of fish and wildlife and their habitat; as a general rule, the proposed measures should provide for habitat of similar type and equal in quantity and quality to that destroyed or damaged."

- to provide information necessary to determine when and where it may be necessary to construct big-game drift fences in the vicinity of the tract to direct big-game movements around or away from oil shale development areas.

.2 Scope of Plan

This plan addresses activities on the tract from the time of development planning to post-operation decommissioning. Within this time frame, fish and wildlife management plans for the development, construction and operation periods are considered.

Methods are included in the plan to provide for review and changes, as necessary, either to reflect changes in planned

Fish and Wildlife Plan

.2 Scope of Plan (Continued)

activities during development or to modify mitigation procedures if these should prove inadequate in the future or unnecessary.

The primary geographic scope of this plan is limited to the area of the tract and to those areas of operational activity off-tract directly related to activities occurring on the tract.

In implementing the Fish and wildlife Plan, the Lessee will cooperate with governmental agencies and groups through the Oil Shale Office in accordance with the Stipulations.

.3 Goals and Objectives

Objectives in formulating the Fish and Wildlife Plan have been considered on two levels:

On-Tract Considerations. Basin-wide historical information, along with the data being obtained in the baseline aquatic ecology and fauna studies have been utilized to analyze the significance of the tract in the regional setting with respect to animal use and adjacent aquatic habitat.

The plan includes general policies as well as specific procedures to minimize adverse effects from development on fish and wildlife. Procedures are also included to enhance and maximize potential positive effects.

Fish and Wildlife Plan

.3 Goals and Objectives (Continued)

Plans for providing alternate habitat and other special programs are considered.

Regional Considerations. Records and historical data for regional terrestrial and aquatic wildlife habitats, population levels and fluctuations, and migratory movements have been reviewed.

General policies and specific procedures have been developed to coordinate plans with government agencies and appropriate private entities.

.4 Implementation

This section sets forth the general strategy which the Lessee plans to employ to minimize adverse effects on fish and wildlife from development of the tract. It also addresses potential problem areas. Background information on wildlife and principal tract habitats are contained in Section 9.9.6. Potential problems, by species or groups affected, are shown on Table 9.19. A more detailed review of schedules and potential impacts of specific activities appears in 9.9.12 and 9.9.13.

The procedures discussed in this plan are based on present understanding of the wildlife effects which might be expected from develpoment of the tract. As development proceeds, the

X = Important Relationship
* = Wildlife Species Not Identified on Tract C-b but known to Occur Regionally

Specific Problem Areas

Important Wildlife	Significant Modification of Terrestrial Habitat	Erosion in Terrestrial Habitats	Modification of Aquatic Hebitats	Erosion and Siltation Affecting Aquetic Hebitats	Water Pollution Affecting Aquatic Hebitets	Management of Water Quality Control Reservoir	Effects of Air pollution	Effects of Noise	Vehicle-Wildlife Collisions	Secondary Impacts resulting from growth in human population	Personnel Menagement	Access Management	Reduction in Ground-water Discharge affecting Terrestrial and Aquatic Habitat	Wildlife Disturbance Resulting from Human Activities
Memmals														
mule deer	X					X			X	X	X			X
desert cottontail	X	X												
bobcat	X									X	X			
coyota	X					X				X	X			
small memmels	X	X												
elk								X		X	X			X
beaver										X	X		X	
wild horse*														
mountain lion*								X		X	X			
ringtail*										X	X			
Birds														
waterfowl					X	X				X	X		X	
doves	X									X	X		X	
passerines & other small birds	X												X	X
raptors	X						X			X	X			
peregrine falcon*	X						X			X	X			
prairie falcon	X						X			X	X			
sage grouse*										X	X			
blue grouse*										X	X			
Fish														
brook trout			X	X	X									
rainbow trout			X	X	X									
forage fish			X	X	X									
cyprinids*				X										

Fish and Wildlife Plan

.4 Implementation (Continued)

monitoring programs which are required by the Stipulations will give an indication of the effectiveness of the procedures. In the event that procedures are shown to require modification, these modifications will be made with the approval of the OSO. Specific plans for mitigation of damage will be submitted for approval to the OSO 60 days prior to a Lessee action which might result in significant damage or destruction of fish or wildlife habitat.

The Environmental Manager is responsible for supervising the activities covered in this plan for the life of the project. He will insure that the specific tasks needed to achieve the goals of the plan are completed as specified. He will also monitor the indicators used to evaluate whether a particular aspect of the plan is effective. Regulations concerning actions of personnel which might affect wildlife will be enforced by him.

.5 Description of C-b Tract

A complete description of the existing environment is given in the Annual Summary and Trends Report (November 1974 through October 1975) of the environmental baseline report. Additional information is contained in the Quarterly, Annual Reports and Section 2.0 of this document. Pertinent parts are summarized here for continuity of this plan.

Fish and Wildlife Plan

.5 Description of C-b Tract (Continued)

Topography. Topography has considerable variation in landform. The rounded ridges in the center of the tract are bisected by shallow V-shaped drainages. Two, larger, U-shaped drainages bisect the tract on the east and west edge of the tract. The sides of these drainages are generally steep and rim rocked. The rimrock is the outcropping of the Uinta sandstone formation which overlies (1,000-1,300 feet) the oil shale (marlstone).

Drainages run generally south to north with an elevation drop from 7,100 to 6,400 feet. Piceance Creek flows east to west, one-half mile north of the tract.

The Roan Plateau cliffs mark the southern boundary of the basin approximately fifteen miles to the south, and serve as the head water for drainages tributary to Piceance Creek.

.6 Existing Wildlife Habitat (Flora)

Fifteen categories of wildlife habitats have been defined describing what is currently known about wildlife distributions on the tract. These are referred to as habitat types, since they are recognizable units of the landscape that support a more or less distinct assemblage of wildlife species. They are not habitats in the strict sense of being the "home" of a particular species. It should be emphasized that the categorization is arbitrary and solely for the purpose of conveniently describing

.6 Existing Wildlife Habitat (Flora) (Continued)

animal populations which continually change in time and space. Other systems may be equally valid. The four habitat types that comprise most of the habitat of the tract are explained in greater detail.

Pinyon-Juniper Woodlands (P-J). Pinyon-Juniper woodlands are the most common and widespread vegetation type on the lease tract and surrounding area. The pinyon-juniper is classified as mature, with most stands over 100 years old. Most of the woodlands on the tract have poorly developed herb and shrub layers. Dominant understory shrubs consist primarily of sagebrush, service berry, bitterbrush and mountain mahogany. Herb understory is mainly western wheatgrass and fleabane with Indian rice grass on the drier, shallower soils. (See Table 9.20 for species composition.)

Productivity of the Pinyon-Juniper vegetation type is the lowest of any type on the tract; it ranges from 185 to 305 lbs/acre (see Table 9.21).

Chained Pinyon-Juniper. Chained pinyon-juniper appears to be a shrubland with many fallen trees. Since chaining in 1967, the pinyons and junipers have made some recovery (130 pines per acre and 105 junipers per acre). Chaining was mostly restricted

Table 9.20
PINYON-JUNIPER TYPE

:CIES		PERCENT FREQUENCY*
ees (Saplings)		
Juniperus osteosperma	Utah juniper	2
Pinus edulis	Pinyon pine	6
·ubs		
Amelanchier alnifolia	Serviceberry	2
Artemisia tridentata	Big sagebrush	4
Chrysothamnus nauseousus	Rubber rabbitbrush	2
·bs		
Agoseris glauca	False dandelion	44
Agropyron smithii	Western wheatgrass	74
Antennaria rosea	Pussy toes	44
Arabis holboellii	Rock cress	30
Astragalus purshii	Pursh-locoweed	2
Astragalus kentrophyta	Kentrophyta milk vetch	34
Bromus tectorum	Cheatgrass	8
Calochortus nuttallii	Sego lily	12
Carex pensylvanica	Sedge	34
Chenopodium album	Goosefoot	22
Colliusua paruifbra	Blue eyed mary	10
Collomia umbellata	Phlox	36
Cymopterus montanus	Cymopterus	20
Descurainia pinnata	Tansy mustard	8
Erigeron sp.	Fleabane daisy	48
Festuca brachyphylla	Sheep fescue	52
Koelena glacilis	Junegrass	43
Lappula redowskii	Stick seed	8
Lomatium orientale	Wild parsley	8
Oryzopsis hymenoides	Indian rice grass	8
Phlox hoodii	Moss phlox	52
Phlox longifolia	Long leafed phlox	66
Poa fendleriana	Mutton grass	20
Sphaeralcea coccinea	Copper mallow	20
Stephanomeria tenuifolia	Wire lettuce	14
Stipa comata	Needlegrass	34

ercent of plots sampled containing that species.

Vegetation Type	Condition	Acres	Herb Production lbs/acre	Acre/AUM*	Estimated AUM
Pinyon Juniper	poor	1965	240 + 65	5	393
Chained Pinyon Juniper	good	2192	460 ± 141,20	3	731
Upland Sagebrush	good	553	380 + 120	2.6	213
Valley Sagebrush	poor	390	275 ± 40	4.7	83
				TOTAL	1420 A.U.M.

* AUM = Animal Unit Month

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.6 Existing Wildlife Habitat (Flora) (Continued)

to ridges and gentle hillsides. The dominant species include big sagebrush, bitterbrush, and saplings of pinyon pine and Utah juniper. Three perennial grass species are common: Indian rice grass, squirreltail grass and western wheatgrass. Cheatgrass, goosefoot and tansy mustard are the main annual species.

The chained rangelands constitute ecologically unstable communities. Successional ranges have been in progress since 1966, but may take 100-200 years for the rangeland to return to a woodland vegetation. (See Table 9.22 for species composition.)

Vegetative production in the chained pinyon-juniper ranges from 299 to 621 lbs/acre (Table 9.21). Production in the chained rangelands shows the greatest variation of any of the vegetation types and is the second most productive in terms of herbage standing crop.

This type received the heaviest grazing use due to its high productivity, variation and palatability of the vegetation. Generally deer use the edges, approximately the first 100 yards from the Pinyon-Juniper type, but cattle use the entire type.

Valley Sagebrush. Valley sagebrush is widely distributed throughout the Piceance Basin, depending on soil salt concentration; the alluvial fans and valleys support big sagebrush

Table 9.22
CHAINED PINYON-JUNIPER TYPE

ECIES		PERCENT FREQUENCY*
ees (sapling)		
Juniperus osteosperma	Utah juniper	0
Pinus edulis	Pinyon pine	2
rubs		
Amelanchier alnifolia	Serviceberry	4
Artemisia tridentata	Big sagebrush	8
Chrysothamnus nauseosus	Rubber rabbitbrush	10
Gutierrezia sarothrae	Snakeweed	12
rbs		
Agoseris glauca	False dandelion	6
Agropyron desertorum	Crested wheatgrass	36
Agropyron smithii	Western wheatgrass	18
Antennaria rosea	Pussy toes	8
Arabis holboellii	Rock cress	20
Bromus tectorum	Cheat grass	88
Carex pensylvanica	Sedge	18
Chenopodium album	Goosefoot	84
Collinsia paruiflora	Blue eyed mary	10
Cryptantha sp.	Little cryptantha	12
Descurainia pinnata	Tansy mustard	24
Erigeron sp.	Showy fleabane daisy	20
Festuca brachyphylla	Sheep fescue	6
Gayophytum ramocissiumum	Groundsmoke	8
Haplopappus nuttallii	Goldenweed	8
Koeleria gracilis	June grass	20
Lappula redowskii	Stickseed	24
Microsteris micrantha	Microsteris	8
Oryzopsis lymenoides	Indian rice grass	38
Phlox hoodii	Moss phlox	16
Poa sp.	Mutton grass	32
Sitanion longifolium	Squirreltail	40
Stipa comata	Needle grass	8
Taraxacum officinale	Common dandelion	12

*ercent of plots sampled containing that species

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.6 Existing Wildlife Habitat (Flora) (Continued)

(intermediate salt levels), greasewood (higher salt concentrations) and rabbitbrush on areas which have apparently been disturbed, probably by fire. The stream trenches support narrow bands of lush semi-aquatic vegetation, and the flat floodplains originally supported Great Basin wild rye communities. Remnants of this original pattern of vegetation can still be found along the upper reaches of Piceance Creek near Rio Blanco Store. Cheatgrass, western wheatgrass, goosefoot and stickseed are also found in this vegetation type (See Table 9.23).

Productivity ranges from 275-780 lbs/acre and is mostly from the shrubs. The lower figure (275) represents herb layer production, and the higher figure represents herb and shrub standing crop (see Table 9.21). Highest production was in big sagebrush where there was not only yearly increase in plant weight, but also very high sagebrush densities which characterize this vegetation type.

Most of the grazing on the Valley Sagebrush areas is in the spring, when the cattle are moving to the high country, and in the fall when they are returning. The greasewood sub-type on Piceance Creek receives heavy grazing in the winter. This use is the result of cattle concentrating there to be fed hay rather than palatability of the shrubs.

Table 9.23
BOTTOMLAND SAGEBRUSH

ECIES		PERCENT FREQUENCY*
rubs		
Artemisia tridentata	Big sagebrush	54
Chrysothamnus nauseosus	Rubber rabbitbrush	5
Sarcobatas vermiculatus	Greasewood	15
Symphoricarpos oreophilus	Snowberry	2
bs		
Agropyron smithii	Western wheatgrass	70
Agropyron trachycaulum	Slender wheatgrass	10
Androsace septentrionalis	Rock primrose	5
Artemisia ludouiciana	Prairie sage	65
Bouteloua gracilis	Blue grama	20
Bromus tectorum	Cheatgrass	100
Chenopodium sp.	Goosefoot	55
Deseurainia pinnata	Tansy mustard	15
Lappula redowskii	Stickseed	40
Lepidium montanum	Mountain Peppergrass	40
Oryzopsis hymenoides	Indian rice grass	5
Poa sp.	Bluegrass	25
Salsola kali	Tumbleweed	5
Sphaeralcea coccinea	Copper mallow	25
Sporobolus cryptandrus	Sand dropseed	40
Stipa comata	Needle grass	80

ercent of plots sampled containing that species.

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.6 Existing Wildlife Habitat (Flora) (Continued)

Upland Sagebrush. Upland sagebrush communities occur on broad ridgetops and in clearings within the Pinyon-Juniper woodlands. This community type usually does not develop on steeply sloping sites. Big sagebrush is the dominant species with other shrubs relatively unimportant. Saplings of pinyon pine and juniper commonly occur, prickly pear is scattered. Western wheatgrass, junegrass, long-leaved phlox, false dandelion and mariposa lily are common herbs in this vegetation type (see Table 9.24).

Production ranges from 160 to 600 lb/acre. Next to the chained rangeland sites, these communities have the greatest herb-layer production; (approximately 300 pounds per acre). Shrub production in the upland sagebrush communities was much less than in the bottomland communities averaging 250 lbs/acre vs. 750 lbs/acre. But, because the Valley Sagebrush type is low in palatability, seasonal (most of the herb layer species are annuals which are green only in May-June); and over grown (dense stands of Sagebrush over six foot tall), the upland sagebrush type produces more useable forage for wildlife and domestic livestock (see Table 9.21).

Streamside Vegetation. This habitat type ocurs in moist zones along the margins of permanent and ephemeral streams, or near springs, seeps and ponds. Such areas have a limited and

Table 9.24
UPLAND SAGEBRUSH

ECIES		PERCENT FREQUENCY*
ubs		
Amelanchier alnifolia	Serviceberry	5
Artemisia tridentata	Sagebrush	85
Chrysothamnus viscideiflorus	Douglas rabbitbrush	60
Opuntia polyacantha	Starvation cactus	10
Symphoricarpos oreophilus	Snowberry	5
bs		
Agoseris glauca	False dandelion	20
Agropyron smithii	Western wheatgrass	100
Allium acuminatum	Wild onion	15
Arabis holboellii	Rock cress	20
Astragolus pectinatus	Narrowleaf poison vetch	10
A. purshii	Pursh-locoweed	15
A. scopulorum	milk vetch	30
Balsamorhiza sagittata	Arrowleaf balsam root	15
Calochortus nuttallii	Sego lily	35
Carex pensylvanica	sedge	45
Castilleja chromosa	Indian paintbrush	55
Chenopodium album	Goosefoot	25
Collinsia paruiflora	Blue eyed mary	85
Collinsia linearis	Blue eyed mary	40
Comandra umbellata	Bastard toadflax	30
Crepis acuminatus	Hawksbeard	80
Eriogonum umbellatum	Suplhur flowered buckwheat	
Festuca brachyphylla	Sheep festuca	75
Hedysarum boreale	Northern sweet broom	10
Koeleria graeilis	Junegrass	100
Lomatium grayi	Gray's lomatium	30
Lupinus argenteus	Lupine	25
Microsteris micrantha	Microsteris	90
Phlox longifolia	Long leaf phlox	100
Physaria floribunda	Twin pod	75
Polygonum sawatchense	Knotweed	95
Sphaeralcea coccinea	Copper mallow	40
Stipa comata	Needlegrass	65
Trifolium gymnocarpon	Clover	95

rcent of plots sampled containing that species.

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.6 Existing Wildlife Habitat (Flora) (Continued)

scattered distribution, and are typically vegetated by various semi-aquatic sedges, rushes, grasses and herbs.

Open Water. The open water of ponds and streams is important to waterfowl and other simi-aquatic birds and mammals.

Agriculatural Meadows Below 6.500 Feet. An elevation of 6,500 feet was chosen as the altitude frequently observed separating many avian and mammalian species during both summer and winter. This elevation is a fair approximation of the upper limits of mule deer winter range in the valleys.

Various hay meadows and pastures occur along the flood plains of the major streams at lower elevations. Most are irrigated and productive, and are often an important component of deer winter range.

Agricultural Meadows Above 6,500 Feet. The agricultural meadows in the upper valleys are similar to those in the lower valleys, but greater snow cover is likely to be a major factor contributing to differential usage for many wildlife species.

Lower Slopes and Bunchgrass Below 6,500 Feet. The lower slopes of the valleys are frequently vegetated by Indian ricegrass and scattered pinyons and junipers. The south-facing slopes are especially important to deer when the snow is deep.

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.6 Existing Wildlife Habitat (Flora) (Continued)

Lower Slopes and Bunchgrass Above 6,500 Feet. Lower slopes at the higher elevations tend to support a narrower zone of bunchgrass because of continual downward encroachment by mixed mountain shrub.

Lateral Draws. Small draws that cut perpendicularly into larger valleys are common topographic features, especially at lower elevations. They are characterized by a steep, intermittent drainage channel that disects the bedrock at the beginning of the draw and forms a steep-sided channel through the alluvium at the bottom. The usual vegetational pattern is dense, big sagebrush covering a small alluvial fan; mixed mountain shrub on northern exposures (bitterbrush, mountain mahogany, serviceberry, and occasionally oak); and bunchgrass with scattered pinyons and junipers on the southern exposures. Outcrops of sandstone (rimrock) often occur as well. These draws have a particular significance to deer, providing both food and shelter during extreme winter weather.

Rimrock. Most of the sandstone cliffs and ledges occur in close proximity to pinyon-juniper woodlands. These areas provide important denning and nesting areas for mammals and birds.

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.6 Existing Wildlife Habitat (Flora) (Continued)

Burned Areas. Old burns occasionally occur within the pinyon-juniper woodlands. The clearings that result are usually characterized by widely-spaced dead trees and a ground cover in which Indian ricegrass is dominant.

Mixed Mountain Shrubland. Higher elevations are sometimes dominated by shrubby species including big sagebrush, mountain mahogany, serviceberry and bitterbrush. Small stands of mixed mountain shrub also occur at lower elevations on the north slopes of the lateral draws.

Douglas-fir Forests. Isolated stands of Douglas-fir occur on the tract, but to a very limited extent. These stands are represented in some cases by less than a dozen trees. At the higher elevations outside the tract boundary, Douglas-fir forests commonly occur on the cooler north-facing slopes.

.7 Fish and Wildlife (Fauna)

Table 9.25 lists the more abundant mammal species found on Tract C-b.

Mule Deer. Mule deer are abundant in the general vicinity of the tract. The deer in this locality live principally at higher elevations during summer, but from fall through spring large numbers remain close to the tract itself. The tract should be considered part of the total winter range for

Table 9.25
MAMMALS

ientific Name	Common Name
ɪis latrans	Coyote
cellus lateralis	Golden-mantled ground squirrel
telus richardsonii	Richardson's ground squirrel
ethizon dorsatum	Porcupine
amias minimus	Least chipmunk
amias quadrivittatus	Colorado chipmunk
amias umbrinus	Uinta chipmunk
urus crutatus	Sagebrush vole
us townsendii	White-tailed jack rabbit
x rufus	Bobcat
hitis mephitis	Stiped skunk
rotus montanus	Montane vole
rotus pennsylvanicus	Meadow vole
tela erminea	Ermine
tela frenata	Long-tailed weasel
toma cinerea	Bush-tailed wood rat
coileus hemionus	Mule deer
atra zibethicus	Muskrat
ognathus apache	Apache pocket mouse
omyscus maniculatus	Deer mouse
omyscus truei	Pinyon mouse
cyon lotor	Raccoon
ex cinerea	Masked shrew
ex vagrans	Vagrant shrew
vilagus audubonii	Desert cottontail
nonys talpoides	Northern pocket gopher
us princeps	Western jumping mouse

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.7 Fish and Wildlife (Fauna) (Continued)

the deer of the Piceance Creek basin. It is not a significant component of summer range even though a few deer may be seen on the tract during the hottest months. Migrational movements are discussed below.

From September through mid-May, approximately 500 to 1000 deer exist in and about the tract study area (the tract plus one mile of surrounding area). During this period, six habitat types are heavily utilized by the deer: 1) the pinyon-juniper woodlands; 2) chained areas; 3) upland sagebrush communities; 4) lower agricultural meadows; 5) lower, south-facing slopes; and 6) the mixed mountain shrub communities of the small lateral draws. All these habitat types contain one or more plant species important to the survival of deer through the winter. Browse studies conducted on the tract indicate that big sagebrush, mountain mahogany, antelope bitterbrush, serviceberry and rabbitbrush are important shrub browse species, though certain native herbs and grasses and several agricultural species (notably alfalfa) are also important as deer browse.

Pinyon-juniper woodlands provide forage for deer and provide cover and protection from wind. Upland sagebrush and chained areas also are important as feeding areas; and, on fresh snow, it is common to see deer tracks leading from bedding grounds within the woodlands out into these adjacent open areas.

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.7 Fish and Wildlife (Fauna) (Continued)

Agricultural meadows in the lower valleys are particularly attractive to deer during the fall and spring. In the fall of each year following the September-October migratory influx, the meadows between Sorghum Gulch and the P-L ranch road contain many deer. Also, in the spring of the year, large concentrations of deer are again counted in the lower valleys. For example, the count in May for one year within a one mile interval along the road at the Willow/Piceance Creek junction was 208 deer.

Livestock grazing does occur on the mule deer summer/winter range. Cattle are released to graze in the hay meadows in early spring; as the growing season progresses, the cattle move away from the hay meadows, pass through Tract C-b (May) and summer at higher elevations south of the tract. As winter approaches, the cattle move down from the summer range (October), pass through Tract C-b and utilize the hay meadows extensively. The P-L Ranch runs cattle on the Piceance Mountain allotment. Approximately 590 A.U.M.'s can be run on the tract, and additional federal land (1000 acres) for a month in the spring and fall. Productivity measurements for the herbaceous layer indicate very light grazing rates by cattle on-tract. Also, outside studies have shown that where dual use of summer-early fall range by cattle and deer occur, cattle consume grass and grasslike plants

in abundance while grasses are insignificant in the diet of mule deer (Locaas 1958; Wilkins 1957; Dasek 1975). In these areas of dual usage, forbs were the most important item in the mule deer diet (Reynolds 1960).

It appears that the present pattern of use precludes large numbers of deer and cattle from occupying Tract C-b simultaneously. However, dual usage of vegetation types does occur for a limited period during March, April and October when both species utilize hay meadows in Piceance and Willow Creek valleys outside the Tract C-b boundary. The meadows and south-facing slopes along Piceance Creek are the most critical and limiting habitat in severe winters for deer. Snow melts sooner on these lower, south-facing slopes than other areas, and consequently deer are provided with food as well as warmth during times of extreme cold. Furthermore, these same south-facing slopes become important in early spring since it is here that the earliest spring growth occurs.

Other Large Mammals. Elk occasionally occur within the boundaries of Tract C-b as evidenced by tracks and fecal pellets. At higher elevations to the south of the tract, elk droppings are fairly common on certain hillsides and small groups of elk are occasionally seen. According to Colorado Division of

.7 Fish and Wildlife (Fauna) (Continued)

Wildlife estimates, the elk herd in the Piceance Creek basin is increasing.

There have been no sightings or evidence of either wild horses or black bear on the tract. Mountain lion tracks have been seen very rarely in the C-b study area.

Medium-sized Mammals. Medium-sized mammals identified within the study area include the desert cottontail, white-tailed jackrabbit, striped skunk, porcupine, raccon, muskrat, beaver, badger, yellow-bellied marmot, bobcat and coyote.

The coyote is abundant on the tract. Muskrats are common in Piceance Creek as well as in nearby ponds and irrigation ditches. Beavers have been observed also, but no permanent dams occur in the area. Racoons, striped skunks, and badgers are uncommon, but widely distributed, whereas yellow-bellied marmots and white-tailed jackrabbits are common tract residents.

The desert cottontail is the only small game mammal identified on Tract C-b. Desert cottontails are ecologically important because they are a major prey species. Marked yearly changes in density probably occur on tract areas. Such fluctuations have the potential of influencing the population of bobcats, coyotes, and some raptorial birds. Cottontails are most abundant in the

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.7 Fish and Wildlife (Fauna) (Continued)

Valley Sagebrush type, and because rimrock is in close association, these two habitat types are of special significance.

Small Mammals. Small mammals are represented on Tract C-b by shrews, mice, moles, chipmunks, ground squirrels, woodrats, gophers and weasels.

Some of the most abundant as well as conspicious small mammals that occur on the tract are the deer mice, chipmunks and ground squirrels. Deer mice are found in all habitat types. Three species of chipmunks occur; the Colorado, least and Unita chipmunks. The golden-mantled ground squirrel is very common. During the summer it can be seen throughout the tract. A small colony of Richardson's ground squirrels live at the lower end of Sorghum, but none have been seen elsewhere on the tract.

Species of various small rodents are also common on the tract. Although they are rarely seen, they are very important herbivores and are prey species for carnivores and raptors. Their local distributions and importance within the total food web will be discussed later.

Pocket gophers are not numerous on the tract, but their diggings are conspicious, especially in the valley sagebrush and occasionally in the chained and pinyon-juniper habitats. In

Fish and Wildlife Plan

.7 Fish and Wildlife (Fauna) (Continued)

aspen groves at higher elevation diggings are sometimes extensive. This is the same species of pocket gopher that occurs up to timberline throughout Colorado.

Reptiles and Amphibians. The species diversity of reptiles and amphibians on Tract C-b is not large. Table 9.26 lists the species observed on-tract. Lizards were studied because of their abundance and presumable importance in the biological system. Other reptiles and amphibians were observed and noted.

The sagebrush lizard, northern plateau lizard, desert short-horned lizard and wandering garter snake are common. These four species of reptiles can be found in most habitats on the tract. The gopher snake is rarely seen, and only one species of amphibians (the leopard frog) has been identified in the riparian and aquatic habitat types.

Avifauna. The diversity of birds on the tract is impressive considering the general dry environment and limited riparian and aquitic areas. A listing of birds occuring on the tract is listed in Table 9.27. Birds are most common from May to October. By late November, most summer residents and migratory species had left the tract region, and more winter residents had appeared. Many of the wintering species feed and rest in loosely organized

Table 9.26
REPTILES AND AMPHIBIANS

entific Name	Common Name
YSTOMIDAE	
Ambystoma tigrinum utahensis	Utah tiger salamander
IDAE	
Rana pipiens	Leopard frog
ANIDAE	
Phrynosoma douglassi	Short-horned lizard
Sceloporus graciosus	Sagebrush lizard
Sceloporus undulatus	Eastern fence lizard
Urosaurus ornatus	Tree lizard
UBRIDAE	
Thamnophis elegans	Western terrestrial garter snake

ORDER FAMILY Species	Common Name	Season of Observation Fall	 Winter	 Spring	 Summer
ANSERIFORMES					
ANATIDAE					
Anas platyrhynchos	Mallard	x	x	x	x
Anas strepera	Gadwall	x	x		
Anas acuta	Pintail	x		x	
Anas crecca	Green-winged teal	x	x	x	x
Anas discors	Blue-winged teal	x			x
Anas americana	American wigeon	x	x	x	
Anas clypeata	Northern shoveler	x			
Anas cyanoptera	Cinnamon teal			x	x
Aix sponsa	Wood duck			x	
Bucephala clangula	Common goldeneye		x	x	
Bucephala islandica	Barrow's goldeneye		x		
Bucephala albeola	Bufflehead		x		
Mergus serrator	Red-breasted merganser		x		
FALCONIFORMES					
CATHARTIDAE					
Cathartes aura	Turkey vulture	x		x	x
ACCIPITRIDAE					
Accipiter gentilis	Goshawk				x
Accipiter cooperii	Cooper's hawk	x			x
Circus cyaneus	Marsh hawk	x			
Buteo lagopus	Rough-legged hawk	x	x	x	
Buteo jamaicensis	Red-tailed hawk	x		x	x
Aquila chrysaetos	Golden eagle	x	x	x	x
Haliaeetus leucocephalus	Bald eagle			x	

ORDER FAMILY Species	Common Name	Season of Observation Fall	 Winter	 Spring	 Summer
FALCONIFORMES (Cont.)					
FALCONIDAE					
Falco mexicanus	Prairie falcon	x	x		
Falco sparverius	American kestrel	x	x	x	x
GALLIFORMES					
TETRAONIDAE					
Centrocercus urophasianus	Sage grouse	x			
GRUIFORMES					
GRUIDAE					
Grus canadensis	Sandhill crane	x			
RALLIDAE					
Fulica americana	American coot	x			x
CHARADRIFORMES					
CHARADRIIDAE					
Charadrius vociferus	Killdeer			x	
SCOLOPACIDAE					
Capella gallinago	Common snipe	x	x	x	x
Actitis macularia	Spotted sandpiper			x	x
Tringa solitaria	Solitary sandpiper	x			x
Tringa flavipes	Lesser yellowlegs	x			
RECURVIROSTRIDAE					
Recurvirostra americana	American avocet				x

ORDER FAMILY Species	Common Name	Season of Observation Fall	 Winter	 Spring	 Summer
CHARADRIFORMES (Cont.)					
PHALAROPODIDAE					
Steganopus tricolor	Wilson's phalarope				x
COLUMBIFORMES					
COLUMBIDAE					
Zenaidura macroura	Mourning dove	x		x	x
STRIGIFORMES					
TYTONIDAE					
Tyto alba	Barn owl	x			
STRIGIDAE					
Otus asio	Screech owl	x			x
Bubo virginianus	Great horned owl	x	x	x	x
Asio otus	Long-eared owl	x			
Nyctea scandiaca	Snowy owl		x		
Aegolius acadicus	Saw-whet owl				x
CAPRIMULGIFORMES					
CAPRIMULGIDAE					
Phalaenoptilus nuttalli	Poor-will				x
Chordeiles minor	Common nighthawk	x			x
APODIFORMES					
APODIDAE					
Aeronautes saxatalis	White-throated swift				x
TROCHILIDAE					
Selasphorus platycercus	Broad-tailed hummingbird				x

ORDER FAMILY Species	Common Name	Season of Observation Fall	 Winter	 Spring	 Summer
CORACIIFORMES					
ALCEDINIDAE					
Megaceryle alcyon	Belted kingfisher	x		x	
PICIFORMES					
PICIDAE					
Colaptes auratus	Common flicker	x	x	x	x
Sphyrapicus thyroideus	Williamson's sapsucker				x
Dendrocopos villosus	Hairy woodpecker	x			
Dendrocopos pubescens	Downy woodpecker	x	x		
PASSERIFORMES					
TYRANNIDAE					
Myiarchus cinerascens	Ash-throated flycatcher				x
Sayornis saya	Say's phoebe	x		x	x
Epidonax wrightii	Gray flycatcher				x
Epidonax difficilis	Western flycatcher	x			
Contopus sordidulus	Western wood pewee			x	x
Nuttallornis borealis	Olive-sided flycatcher				x
ALAUDIDAE					
Alauda arvensis	Horned lark	x	x		x
HIRUNDINIDAE					
Hirundo rustica	Barn swallow	x			x
Petrochelidon pyrrhonota	Cliff swallow	x			x
Tachycineta thalassina	Violet-green swallow	x			x
Iridoprocne bicolor	Tree swallow				x
Stelgidopteryx ruficollis	Rough-winged swallow				x

ORDER FAMILY Species	Common Name	Season of Observation Fall	 Winter	 Spring	 Summer
PASSERIFORMES (Cont.)					
CORVIDAE					
Cyanocitta stelleri	Steller's jay	X	X		
Aphelocoma coerulescens	Scrub jay	X		X	X
Gymnorhinus cyanocephalus	Pinyon jay	X	X	X	
Pica pica	Black-billed magpie	X	X	X	X
Nucifraga columbiana	Clark's nutcracker	X	X	X	X
Corvus corax	Common raven	X	X	X	X
Corvus brachyrhynchos	Common crow	X			
PARIDAE					
Parus atricapillus	Black-capped chickadee	X	X		
Parus gambeli	Mountain chickadee	X	X	X	X
Parus inornatus	Plain titmouse			X	
SITTIDAE					
Sitta carolinensis	White-breasted nuthatch	X	X		
Sitta canadensis	Red-breasted nuthatch	X	X		
TROGLODYTIDAE					
Troglodytes aedon	House wren	X			X
Salpinctes obsoletus	Rockwren	X			X
Catherpes mexicanus	Canyon wren	X		X	
MIMIDAE					
Sporeoscoptes montanus	Sage thrasher	X			
TURDIDAE					
Turdus migratorius	Robin	X	X	X	X
Myadestes townsendii	Townsend's solitaire	X	X		X
Hylocichla guttata	Hermit thrush				X
Siala currucoides	Mountain bluebird	X		X	X

ORDER FAMILY Species	Common Name	Season of Observation Fall	 Winter	 Spring	 Summer
PASSERIFORMES (Cont.)					
SYLVIIDAE					
Polioptila caerules	Blue-gray gnatcatcher	x			x
Regulus calendula	Ruby-crowned kinglet	x			
LANIIDAE					
Lanius excubitor	Northern shrike	x	x	x	
Lanius ludovicianus	Loggerhead shrike			x	
STURNIDAE					
Sturnus vulgaris	Starling	x		x	
VIREONIDAE					
Vireo solitarius	Solitary vireo	x			x
Vireo olivaceus	Red-eyed vireo				x
Vireo gilvus	Warbling vireo				x
PARULIDAE					
Vermivora ruficapilla	Orange-crowned warbler				x
Vermivora virginiae	Virginia's warbler				x
Dendroica petechia	Yellow warbler				x
Dendroica coronata	Yellow-rumped warbler	x			x
Dendroica nigrescens	Black-throated warbler	x			x
Dendroica townsendi	Townsend's warbler	x			
Geothlypis trichas	Common yellowthroat				x
Oporornis tolmiei	MacGillvray's warbler				x
Wilsonia pusilla	Wilson's warbler				x

ORDER FAMILY Species	Common Name	Season of Observation Fall	 Winter	 Spring	 Summer
PASSERIFORMES (Cont.)					
ICTERIDAE					
Dolichonyx oryzivorus	Bobolink				x
Sturnella neglecta	Western meadowlark	x		x	x
Xanthocephalus xanthocephalus	Yellow-headed blackbird	x			
Agelaius phoeniceus	Red-winged blackbird	x		x	x
Euphagus cyanocephalus	Brewer's blackbird	x			x
Molothrus ater	Brown-headed cowbird				x
THRAUPIDAE					
Piranga ludoviciana	Western tanager				x
FRINGILLIDAE					
Pheucticus melanocephalus	Black-headed grosbeak				x
Carpodacus mexicanus	House finch	x			x
Leucosticte tephrocotis	Gray-crowned rosyfinch		x		
Leucosticte atrata	Black rosy finch		x		
Leucosticte austcalis	Brown-capped rosy finch		x		
Spinus pinus	Pine siskin	x			x
Spinus tristis	American goldfinch	x			
Chlorura chlorura	Green-tailed towhee	x			x
Pipilo erythrophthalmus	Rufous-sided towhee	x			x
Passerculus sandwichensis	Savannah sparrow	x			
Calamospiza melanocorys	Lark bunting				x
Pooecetes gramineus	Vesper sparrow	x			x
Amphispiza belli	Sage sparrow				x
Junco hyemalo	Dark-eyed junco		x	x	
Junco caniceps	Gray-headed junco	x	x	x	x
Spizella arborea	Tree sparrow	x	x	x	
Spizella passerina	Chipping sparrow	x			x
Spizella breweri	Brewer's sparrow	x			x
Zonotrichia leucophrys	White-crowned sparrow	x			x
Melospiza melodia	Song sparrow	x	x	x	x

.7 Fish and Wildlife (Fauna) (Continued)

flocks which appeared to move over large portions of the tract and to feed in a variety of different habitats. The diversity of raptorial birds is particularly noteworthy. The migratory patterns of the common species are discussed later. The red-tailed hawk, American kestrel (sparrow hawk), rough-legged hawk and great horned owl are the most numerous of those identified. Locations of all raptor nests encountered were mapped and rechecked for occupancy. Night road transects were traversed to assess owl activity. Pellets and casts were collected from nesting, roosting and feeding sites used by birds of prey. One sighting of the prarie falcon (classified as a threatened species) was documented during February 1975. Both the golden eagle and the bald eagle are seen on-tract part of the year. The golden eagle is often seen during summer at the southern higher elevations beyond the tract. A pair of golden eagles nested on the tract during 1975 and 1980. The bald eagle is an uncommon winter resident. Both the bald eagle and golden eagle are seen among the pinyon-juniper and rimrock, and both species are important scavengers of mule deer.

Mourning doves are the most common game bird on the tract. They are most numerous in the lower valleys. Open water is an important component of their habitat, and stock watering tanks

.9 Fish and Wildlife Plan

.7 Fish and Wildlife (Fauna) (Continued)

and ponds in the valley sagebrush habitat type attract large flocks, especially during the dry, late summer period.

Blue grouse, sage grouse and chukar are game birds which occasionally live near the tract. Blue grouse habitat is typically mixed coniferous-aspen forest with adjacent open areas; also utilized are mixed mountain shrub habitats. Sightings have only occurred at higher elevations south of the tract and one bird was sighted on-tract in 1979. Sage grouse depend heavily on sagebrush for food. Evidence of sage grouse (droppings) is occasionally found on-tract near Vegetation Plot #3.

Chukar were released in the general region by the Colorado Division of Wildlife, but the pattern of sightings has been too limited to determine actual distribution, abundance or habitat preferences in the area. No chukar have been observed on or near the tract.

Waterfowl are not abundant in the area because of the limited amount of open water. Mallards, cinnamon teal, green-winged teal and blue-winged teal are the most commonly observed species in summer. During winter, common goldeneye, bufflehead, gadwall, American widgeon and red-breasted merganser are also found, particularly on the larger ponds in the vicinity of the tract.

9.9 Fish and Wildlife Plan

.7 Fish and Wildlife (Fauna) (Continued)

Fish. The primary fish species found near C-b Tract include brook trout, mountain sucker and speckled dace. Piceance Creek is generally characterized by a meandering stream channel, fluctuation flows, high levels of dissolved solids, high turbidity, silted rock and gravel substrates, and infrequent pool and shelter areas for fish. These factors make much of the habitat unsuitable for large gamefish populations. In the vicintiy of the tract, Piceance Creek supports higher populations of fish than are found in Stewart Creek and Willow Creek. The tract is crossed on the west by Willow Creek and Middle Stewart on the east.

Brook trout are the most common game fish found in Piceance Creek and in the lower sections of the major tributaries near the tract. The population is not large, and the creek's present value to sport fishing is minor. Apparently some reproduction of brook trout occurs in Stewart, Piceance and Willow Creeks and in lower Stewart Lake. Rainbow trout occur in some of the ponds within the area, and a few occur in Piceance Creek, but their present recreational value is low.

Mountain suckers and speckled dace are the most common non-game fish found in Piceance Creek and the major tributaries near the tract. The mountain sucker is the most abundant fish species in

9.9 Fish and Wildlife Plan

.7 Fish and Wildlife (Fauna) (Continued)

Piceance Creek. These species are forage fish. They spawn in the streams in the tract vicinity.

Arthropods. A list of arthropods, data on seasonal abundance and distribution are reported in quarterly reports.

Endangered or Threatened Species. It is possible that the two subspecies of the endangered peregrine falcon (Falco Peregrinus var. Falco Peregrinus var. tundrius) occasionally inhabit the area, but no sightings have been documented to date. The nationally threatened prairie falcon (Falco mexicanus) has been sighted once near the tract. None of these three species of falcons is believed to nest inside the tract boundaries. Bald eagles occasionally are observed on-tract and in the general vicintiy. However, no bald eagles nest nor remain on the tract for any great length of time. The C-b Tract is really unsuitable bald eagle habitat because it is only marginal winter range. The greater sandhill crane (state endangered) has been observed in the tract vicinity during migration, but none has been seen during the breeding period. The spotted bat (threatened), the black-footed ferret, Colorado squawfish, humpback chub and pharanagat bonytail (all nationally endangered), and the gray wolf, river otter and wolverine (state endangered), are species of the general region, but none have been reported in the near

.0 ENVIRONMENTAL CONTROL PLANS

.9 Fish and Wildlife Plan

.7 Fish and Wildlife (Fauna) (Continued)

vicintiy of the tract. More significantly, the tract is not good potential habitat for any of these species and could only be considered fair habitat for the prairie falcon and American peregrine falcon.

Other Wildlife of Uncertain Occurrence. Mountain lions have not been reported on the tract by field personnel or local residents. However, they do occur in the vicinity. Black bears have been seen by ranchers at higher elevations, but no sightings have been reported on the tract. Feral horses occur to the west, but their movements do not bring them close to the tract. It is possible that one or more species of foxes (red, gray, or kit fox) could occur on the tract, but only one gray fox has been sighted to date. The ringtail possibly occurs on the tract, but there are no records of sightings or trappings in the immediate area. Snowshoe hare, black-tailed jackrabbit and mountain cottontail could occur on or near the tract, but no identifications have been made. The western rattlesnake and collared lizard are reptiles that are known to be nearby in Parachute Creek, but none has been identified near or on the tract.

.8 The Food Web

The pathways of energy transfer through the local food web are understood only in a general way. Though better quantification

9.9 Fish and Wildlife Plan

.8 The Food Web (Continued)

will be come available later, the major relationships may be characterized qualitatively at this time (Figure 9.15). Such information is particularly relevant to the Fish and Wildlife Plan, since it singles out the more important plant communities which might subsequently be protected or reestablished through revegetation programs. In this respect, food web considerations take on the same management perspective as do considerations of migrational patterns discussed below. Both are concerned with dynamic biological interrelationships, but are viewed in terms of more or less static vegetational and topographic units.

The montane vole occurs mainly in moist agricultural meadows; in drier upland areas it is largely replaced by the long-tailed vole. These two species of "meadow mice" constitue an enormously important food base for both migratory and resident predators of the tract areea. Both species are to some extent cyclic, although in most years populations are likely to be fairly large with peak densities usually reached during mid to late summer.

The significance of the desert cottontail as a food base for predators is similar to that of the voles, and populations of this species also fluctuate widely. Data gathered on the tract so far is conclusive for verification of such trends. The desert cottontail is widely distributed on the tract and although

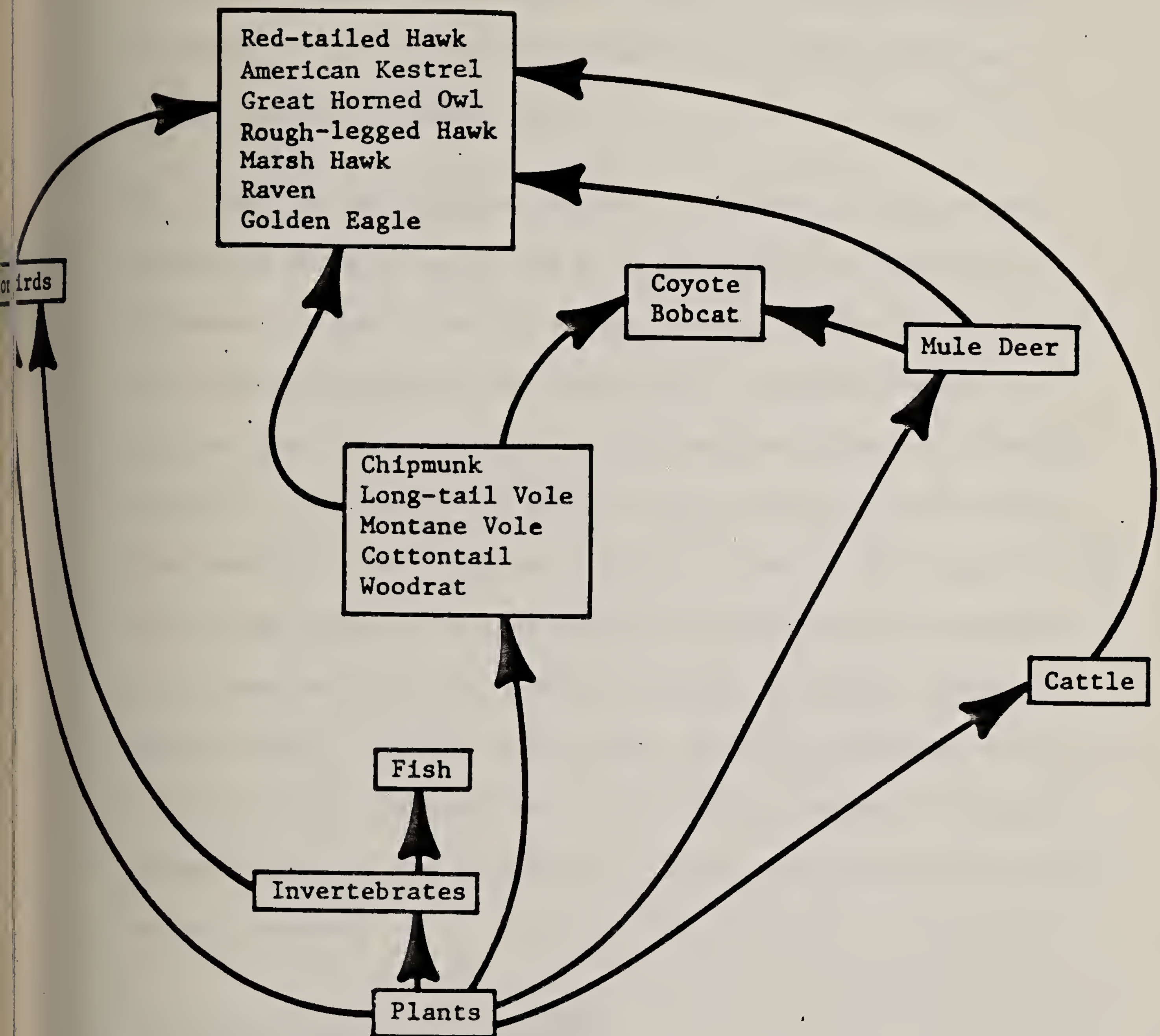


FIGURE 9.15 MAJOR FOOD WEB RELATIONSHIPS

.8 The Food Web (Continued)

it can be found in most habitat types, it is typically most numerous in the pinyon-juniper woodlands, chained areas and valley sagebrush communities.

Mule deer are an important source of carrion for many of the predators which occur in the tract area which at times are scavengers. Such animals include coyotes, golden eagles and occasionally bobcats. The more common scavengers (which typically do not kill prey) include magpies, ravens and turkey vultures. Deer mortality studies have shown that most winter deer deaths occur in the small lateral draws of the major drainages and in the lower valleys adjacent to the agricultural meadows. Such areas are utilized by most of these scavenging animals during winter. To what extent deer fawns or adult deer are acutally killed by predators is not known. However, the deer telemetry study, now in progress, should give us more information on this problem.

.9 Migratory Patterns of Mule Deer

There is confusion regarding the definition of migratory deer in the Piceance Creek basin. On one hand, deer commonly migrate in mountainous areas, from higher summer range to lower winter range. On the other hand, the migratory deer herd of the Piceance Creek basin is famous because of impressive movements

.9 Migratory Patterns of Mule Deer (Continued)

over longer distances. These have been reported in past years. Accounts vary, but massive movements are supposed to have occurred in an east-west direction to and from a summer range located 20 to 60 miles away from the tract.

It is difficult to determine where deer go on a year-round basis and to sort out their summer movements when they disperse widely throughout remote terrain. The deer studies conducted for the tract have provided information concerning diurnal deer movements and information concerning major fall-spring movements within the tract study area. In additin to our studies, C-b Tract personnel are cooperating in a study being conducted jointly by the Department of Energy and the Colorado Division of Wildlife. The study is trying to define the migrational habitats of the Piceance Creek Mule Deer herd by tracking deer movements through radio-collared deer. Results from this study should greatly increase our knowledge of deer movements. However, there is no suggestion from several related deer studies that their observed movements represent any kind of unusual behavior. For this reason, and until there is evidence to the contrary, it seems justified to use such phrases as migratory routes, migrational pathways, etc., to indicate the ordinary and typical movements of deer to and from nearby summer range, and not to consider the deer in the tract area as being exceptional in this regard.

9.9 Fish and Wildlife Plan

.9 Migratory Patterns of Mule Deer (Continued)

Some ridges on the tract seem to be used by deer somewhat more heavily than others during the fall-spring period. Those ridges most heavily used, as indicated by a study performed during October 1975, are located: along Little Scandard Gulch; east of Sorghum Gulch; and east of Middle Fork Stewart Gulch. These are long and continuous ridges extending approximately 10 to 12 miles to the south to the Piceance/Parachute Creek and Piceance/ Roan Creek divides. Other adjacent ridges are similar, but some topographic and vegetational differences occur.

The higher elevations to the south of the tract are believed to be the summer range for many of the deer that winter on the tract. The lower limit of summer range can be described as a gradient, ending approximately at the upper limit of the pinyon-juniper woodland.

The winter range extends from Piceance Creek up to the summer range. The winter and summer ranges seem to overlap between 7,500 and 7,800 feet.

.10 Migratory Patterns of Raptors

During early spring there are relatively few raptorial birds in the tract area. The nesting species that occur include great-horned owls, red-tailed hawks, kestrels, golden eagles, Cooper's hawks and marsh hawks. As the season progresses, more

9.9 Fish and Wildlife Plan

.10 Migratory Patterns of Raptors (Continued)

red-tailed hawks and kestrels can be seen; these two species become the most numerous raptors throughout summer. Marsh hawks are occasionally seen during summer, and they become more common during early fall. Rough-legged hawks only become abundant during the fall, but they remain throughout the winter months. In 1974-1975 they were the most numerous wintering raptors. Great-horned owls are common on the tract year-round.

During the fall periods when raptor diversity is highest, habitats utilized by these birds tend to differ, although considerable overlap in their respective hunting areas occurs. The lower valleys are of singular importance, since this habitat is utilized most heavily by all species. Frequently red-tailed hawks, rough-legged hawks, marsh hawks and kestrels can be seen sharing the same meadow and preying almost exclusively on montane voles. The differential habitat usage area among these birds is sometimes very subtle. The rough-legged hawk, for example, restricts its hunting almost entirely to the lower valleys, and inhabits the area only during the colder months of the year. The red-tailed hawk tends to utilize a wider range of habitat types, including the denser areas of pinyon-juniper woodland, rimrock and shrubby draws, where it commonly feeds on the desert cottontail. Kestrels feed more commonly on grasshoppers when the insect are numerous, but they also share populations

9.9 Fish and Wildlife Plan

.10 Migratory Patterns of Raptors (Continued)

of montane voles and long-tailed voles with other raptors when rodents are at high densities. Differences in habitat segregation and in the timing of migratory movements tend to reduce competition for similar food sources. Although these behavioral differences may not be obvious among the raptors found in the tract area, they are nevertheless important in sustaining these predatory birds, which have a relatively insecure position at the very ends of the local food chains.

.11 Importance of Species

The matrix shown in Table 9.28 lists the wildlife found on the tract and ranks selected species according to their relative importance. Since all species do not have the same aesthetic, economic or ecological value to all individuals, the judgments reflected in this matrix, although based on data collected during our field investigations, are of a subjective nature.

.12 Proposed Action

A complete description of the proposed action is given in previous sections of the revised Detailed Developmental Plan. The area of primary development activity involves approximately 2027 acres in the central portion of the tract. The 2027 acres utilized for mine surface facilities, plant site, processed and raw shale disposal, liquid and solid storage and related support

TABLE 9.28 IMPORTANT WILDLIFE IN THE VICINITY OF TRACT C-b
(Evaluations are ranked as H = high, M = medium, L = low, and are the subjective judgments of the Fish and Wildlife Management Committee)

Wildlife Species	Importance Criteria			
Only species, or groups (indicated by plurals), which are considered of possible importance are listed. For a complete listing of species see baseline wildlife studies.	Aesthetic visually attractive; rare, endangered, or threatened.	Economic game species, of agricultural significance	Ecologic herbivores, prey species, predators	Poisonous animals and Disease Vectors
Mammals of common occurrence on Tract C-b:				
Mule Deer	H	H	H	–
Desert Cottontail	M	M	H	L (Potential vector of Tularemia)
Bobcat	H	M Furbearers potentially important to sheep ranchers	M	–
Coyote	L-H (controversial)	M	H	–
Raccoon	M	M	M	–
Striped Skunk	M	L	L	L (Potential vector of Rabies)
Weasels	M	L	M	–
Small Mammals:	M	M-L	H	–
Chipmunks				
Ground Squirrels				
Pocket Gopher				
Woodrat				
Mice				
Voles				
Shrews				
Muskrat	M	L	L	–
Porcupine	M	L	L	
Bats	L	L	L	L (Potential vector of rabies)
Mammals of uncommon occurrence on Tract C-b:				
Elk	H	M	L	
White-tailed Jackrabbit	L	L	L	–
Badger	M	L	L	–
Beaver	H	M	L	–
Yellow-bellied Marmot	M	L	L	–
Mammals not identified on Tract C-b but known to occur regionally and which could be affected by oil shale development:				
Wild horse	H (Controversial)	L	L	–
Black Bear	M	M	M	–
Foxes	M	L	M	–
Mountain Lion	H	H	H	–
Ringtail	H	L	L	–
Birds of common occurrence on Tract C-b:				
Waterfowl:	H	M	L	–
Mallard				
Green-winged Teal				
Common Goldeneye				
Cinnamon Teal				
Blue-winged Teal				
Bufflehead				
Raptors:	H	L	H	–
Red-tailed Hawk				
Rough-legged Hawk				
American Kestrel				
Marsh Hawk				
Golden Eagle				
Great Horned Owl				
Mourning Doves	M	M	M	–
Passerines and other small birds:	M-L	M	H	–
Songbirds				
Woodpeckers				
Swifts				
Hummingbirds				
Shrikes				
Birds of uncommon occurrence on Tract C-b:				
Prairie Falcon	H	L	L	–
Bald Eagle	H	L	L	–
Cooper's Hawk	M	L	L	–
Goshawk	H	L	L	–
Birds not identified on Tract C-b but known to occur regionally, and which could be affected by oil shale development:				
Sage Grouse	M	L	L	–
Blue Grouse	H	L	L	–
Peregrine Falcon	H	L	L	–
Greater Sandhill Crane	H	L	L	–
Sharp-shinned Hawk	M	L	L	–
Reptiles and Amphibians of common occurrence on Tract C-b:				
Sagebrush Lizard	L	L	M	–
Northern Plateau Lizard	L	L	L	
Reptiles and Amphibians of uncommon occurrence on Tract C-b:				
Short-horned Lizard	L	L	L	–
Gopher Snake	L	L	L	–
Wandering Garter Snake	L	L	L	–
Western Rattlesnake	L-M (Controversial)	L	L	M (Populations are low)
Fish of common occurrence on Tract C-b:				
Brook Trout	L	L Of potential importance	L	–
Rainbow Trout	L	L	L	–
Forage Fish	L	L	M	–
Mountain Sucker				
Speckled Dace				
Mottled Sculpin				
Fish not identified on Tract C-b but known to occur regionally, and which could be affected by oil shale development:				
Possibly three species of cyprinids: Colorado squawfish, humpback chub, and pahranagat bonytail	H	L	L	–

9.9 Fish and Wildlife Plan

.12 Proposed Action (Continued)

facilities will undergo major modifications. Within this intensive development zone, revegation and erosion control measures will serve to minimize the effects of development on wildlife. Revegetation work on disturbed areas and processed shale disposal areas will emphasize plant species of importance to wildlife. However, the principal focus will be on the rapid establishment of vegetative cover and the consequent minimization of erosion. Details of the revegetation program are developed in the Erosion Control and Surface Rehabilitation Plans, and are not repeated here. Post-operation decommissioning will include revegetation plans for the eventual reestablishment of habitats to support a balanced number of types of native fauna.

Site preparation and preconstruction began in September 1977 and continues while shaft sinking is underway. During this phase, preparation or extension of service roads, construction of water storage to receive underground water from initial dewatering operations, necessary grading for temporary construction facilities, fencing, etc. has taken place. The milestone dates are referenced on the Master Schedule (Figure 3.1).

The mined shale will be transported by a conveyor belt system to Cottonwood and Sorghum Gulches. Raw and processed shale

9.9 Fish and Wildlife Plan

.12 Proposed Action (Continued)

piles, along with the topsoil stockpile, account for nearly 81 percent of the toal 2,027 acres disturbed. Processed shale disposal will affect nearly 1,346 acres, or approximately 66 percent of the total acreage disturbed. In the year 2017 surface disruption will cease because the processed shale pile will grow only in height; but mine development activities continue into 2028.

In addition to the mining activities a starter dam may be built in "No Name Gulch" to provide for impounding water during the early stages of development. Plans for a dam in Willow Creek are also being discussed.

.13 Impacts on Fish and Wildlife

Mine Development. The mine development phase will result in limited activity on the tract. The major effects of the proposed development mining operation will be changes to the habitat of small mammals and summer bird populations presently utilizing the surface areas which will be disturbed. Since the habitat in surrounding areas is similar, limited animal movement from disturbed areas will occur, with some repopulation and recolonization of the surrounding undisturbed areas. After rehabilitation and restoration of disturbed areas, repopulation and recolonization may proceed by immigration from surrounding

9.9 Fish and Wildlife Plan

.13 Impacts on Fish and Wildlife (Continued)

undisturbed areas. Rapid reclamation upon cessation of the planned activities is important and should result in the land being able to support animal populations equivalent to those now present.

In the mine development phase, the greatest effect on the deer populations will probably be increased road kills as a result of increased traffic.

Small mammals will probably undergo local population modifications and an overall reduction of numbers and density with habitat destruction. There will also be minor shifts in composition and diversity. For example, deer mice will probably increase while the sagebrush vole, which is at its southern limits of distribution, and the Apache pocket mouse, which is near its northern distributional limits, will likely diminish in number. There may also be a decrease in the abundance of the three species of chipmunk (the least, Uintah and Colorado), but at this time it cannot be predicted what changes will occur in these populations due to modifications in habitat.

Changes in habitat resulting from mine development and the presence of man will probably reduce, locally, the numbers of certain species of song birds. Birds, such as the chickadees and pine siskins, which inhabit wooded areas will probably

9.9 Fish and Wildlife Plan

.13 Impacts on Fish and Wildlife (Continued)

stay away from the cleared areas where human activities are occuring, On the other hand, an increase in flock-like species, such as horned larks, that inhabit open areas will probably occur.

Raptor populations in the area may decrease, although raptor eyries and principal nest sites are not located close to mine development areas. If substantial changes in mammalian populations occur, changes may also occur in the abundance of certain raptor species. However, the small percentage of habitat to be disturbed relative to the total extent of similar habitats in the region suggests that local reductions in small mammal numbers should not have significant consequences on the habitat of wide-ranging raptorial species. As a result of the increased presence of man, poaching could have an impact on raptors.

Waterfowl and upland game birds will probably undergo minimal disturbance in this phase, although poaching could affect both populations.

The preferred habitats of most reptilian species are the rocky, south-facing valley slopes and the densely vegetated valley areas near streams. Changes in these preferred habitats and, consequently, effects on these species, are expected to be negligible. There are not endangered reptilian or amphibian

9.9 Fish and Wildlife Plan

.13 Impacts on Fish and Wildlife (Continued)

species in the area and no critical habitats that will be significantly damaged.

Fish and aquatic invertebrates should not be affected as a result of the shaft sinking and mine development since it is unlikely that the surface water flows will diminish. Piceance Creek has a high siltation rate during spring runoffs. Siltation resulting from erosion during construction activities will be controlled, but some runoff may occur which could degrade water quality and adversely affect aquatic species, especially if occuring during fish spawning periods.

Spawning activities by game and non-game fish take place in Stewart Creek and Piceance Creek and probably to some extent in Willow Creek. Fish are more abundant in the streams in the vicinity of the tract than in downstream stretches of Piceance Creek near the White River. Because of degraded water quality and unsuitable substrate in lower Piceance Creek, more fish probably spawn in the tract vicinity and upstream of the tract than in downstream portions of Piceance Creek near the White River. Brook trout spawn in the fall in the creeks and probably in lower Stewart Lake. Non-game fish spawn in the spring and summer in the creeks in the vicinity of the tract.

9.9 Fish and Wildlife Plan

.13 Impacts on Fish and Wildlife (Continued)

Plant Construction and Plant Operations. Since the land disturbances caused by plant construction activities will extend into the operating period, the disturbances caused by these phases are discussed together.

Wildlife may be adversely affected by: 1) destruction or alteration of habitat and reduced quantities of forage as a result of land disturbance, particularly the construction of the processed shale disposal embankment; 2) disturbance resulting from human and mechanical intrusion; and 3) the possibility of poisoning as a result of accidental petroleum and toxic chemical spills. Clearing activities in pipeline and powerline rights-of-way and the increase in human population could also have a detrimental effect on animals. As an indirect consequence of development of the tract, alterations in distribution and abundance of certain animal species are expected to result from increased road activity, hunting, trail biking and snowmobiling.

The access roads to the plant site and to the mine surface facilities represent hazards to mule deer because of the potential for road kills. The potential for road kills during most years will be highest during October and November and again during March and April, when areas in close proximity to the highway are most heavily used by large concentrations of deer.

9.9 Fish and Wildlife Plan

.13 Impacts on Fish and Wildlife (Continued)

Road kills, loss of browse species, and movement restrictions due to construction activities will probably have the greatest effect on the mule deer populations. Unless controlled, harassment and poaching could also have serious consequences.

In addition to mule deer, other animals occasionally killed by road traffic include other big game species, small and medium-sized mammals, birds and reptiles. However, the cumulative adverse effect on these species of the proposed roads and traffic in the Piceance Creek area is expected to be minor.

A precise determination of the consequences of visual and audible disturbances of fauna is not possible because of the lack of behavioral information and the uncertainty regarding the degree of disturbance attributable to such factors. These disturbances will be local because they will not extend more than a mile from the source, except under very unusual circumstances. It has been found that deer adapt to human activity and noise. Operations at Colony's plant in Parachute Creek appeared to have had little influence on their overt behavior.

Medium-sized mammals, birds, reptiles and amphibians will experience approximately the same effects as during the previous phase. The greatest effect will be reduced populations in localized areas where habitat has been disrupted. Introduced

9.9 Fish and Wildlife Plan

.13 Impacts on Fish and Wildlife (Continued)

small mammal species, such as rats and house mice, may move onto the tract, since they are associated with human activity.

Most of the influences on the aquatic communities will depend upon the degree of erosion, the extent of dewatering, and the storage, treatment and use of mine and imported water. Dust may also affect the water quality of local streams and ponds. Diminished stream flow resulting from mine activity would adversely affect aquatic communities.

Post-operations. Disturbance during post-operation activities will be temporary. Ultimate effects on fish and wildlife will be beneficial due to returning of disturbed areas to usable habitat.

.14 Estimated Effects of Action on Wildlife

Complete modification of terrestrial habitats will occur during the filling of reservoirs, during the covering of productive biotic communities at the processed shale disposal site, and during preparation for the construction of roads and facilities. Such modifications will render the particular sites unsuitable for wildlife. Reduction of terrestrial habitats will continue to occur throughout mine development, plant construction and operation periods, and will affect approximately 2027 acres.

.14 Estimated Effects of Action on Wildlife (Continued)

Most site development and all construction activities will contribute to the modifications. In addition to these major modifications, other more subtle changes in habitat composition may occur due to minor alterations in surface runoff and minor changes in air quality.

The major effects on the fauna will be due to habitat disturbance and increased human activity. A total of approximately 2027 acres will be affected. Complete modification of terrestrial habitats will occur during preparation for the construction of roads and facilities, filling of reservoirs, and the depositing of the raw and processed shale on the tract. Such modifications will render those sites unsuitable for wildlife until they can be reclaimed.

The areas utilized most intensively by mule deer between October and April are off-tract in Piceance Creek valley and the contiguous south-facing slopes. Nevertheless, deer also ranged over the entire tract through much of the winter. Based on preliminary investigations of the tract region, it was concluded that winter deer concentrations are generally higher in the immediate tract vicinity than in areas a few miles from the tract. Reduction of winter range by 2027 acres in this area will significantly diminish the tract's carrying capacity until the reclaimed areas

.9 Fish and Wildlife Plan

.14 Estimated Effects of Action on Wildlife (Continued)

are mature enough to withstand grazing pressure. The areas disturbed by construction of the surface facilities are located in one small chained area and in a large block of chained pinyon-juniper (see Figure 9.16 and Table 9.29). The presence of the facilities, coupled with the constant presence of people, may cause deer to use other areas. Data suggest that approximately 40 deer that use the proposed facility areas may be displaced (26.7 deer-days/acre divided by 216 days equals .123 deer/acre multiplied by 500 estimated acres equals 62 deer per year affected).

Disposal of processed shale in Sorghum Gulch and Cottonwood Gulch will have the major impact on deer and wildlife in general. The fringe of pinyon-juniper along these drainages serve as travel corridors for deer moving to and from Piceance Creek during migration. It is estimated from the baseline data that approximately 185 deer will be forced to a different ridge during migration (.123 deer/acre multiplied by 1500 acres equals 185). In a severe winter, the upper limit of deer winter range may coincide with the disposal site.

An estimated 235 A.U.M.'s will be lost for livestock used during development. At the current grazing price, this represents a loss of approximately $555.00 to the BLM. Most of this loss

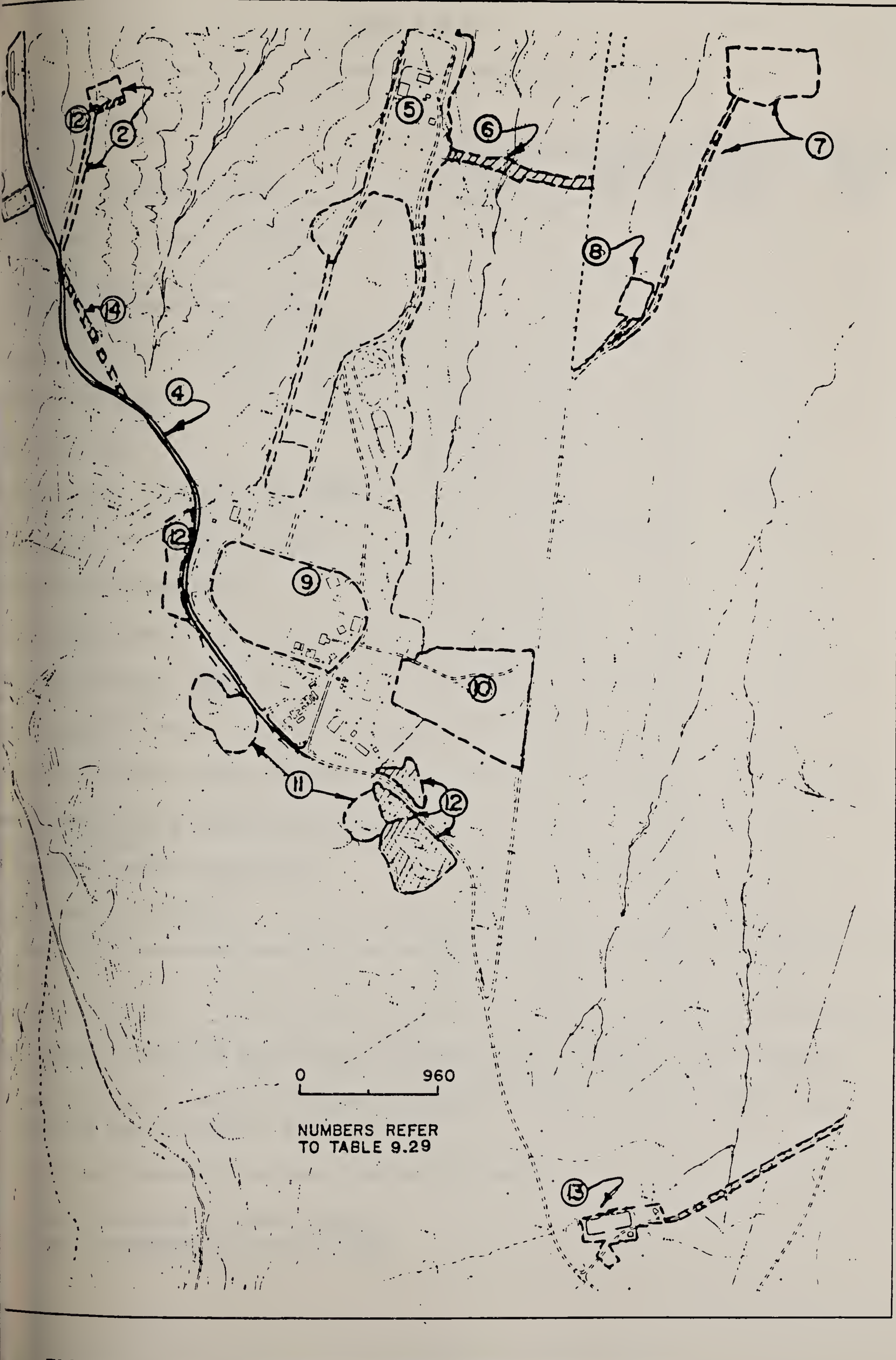


FIGURE 9.16 C-B TRACT DISTURBED AREAS MAP

TABLE 9.29

Estimates of Disturbed and Revegetated Acreage[1]

Disturbed Area[2]	Acreage Disturbed Before 1980	Acreage Disturbed During 1980	Acreage Revegetated Before 1980	Acreage Revegetated During 1980
Guard House & Truck Scale Area	3.4			
Sewage Treatment Plant & Road		1.4		
13) Topsoil Stockpile at site		0.3		0.3
Heliport & Public Relations Facility	0.6			
Main Access Road	23.5			
Ancillary Area	17.2			
Proposed Dam Site (East No Name)	1.2		1.2	
Switchyard Area & Access Road		6.1		
Explosive Storage Area	1.8			
Mine Support Area	72.2			
Raw Shale Storage Area	6.0	5.0		
Rock Stockpile Areas	7.7			
Topsoil Stockpiles (near Support Area)	5.5	3.0	5.5	3.0
Water Discharge & Application Area (Pond "C" Area)	3.7			
Irrigation System Pipelines[3]	4.0	4.0		
Abandoned Access Road	10.0		10.0	
s[4]				

ges revised from 1979 Annual Report based on aerial photos taken in 1980.

rated disturbed acreage in column corresponds to that shown on "C.B. Tract rbed Areas Map", Figure 9.9-2.

ge is an estimate-did not come from aerial photos.

acreage disturbed to date = 172.6
acreage revegetated to date = 24.0

9.9 Fish and Wildlife Plan

.14 Estimated Effects of Action on Wildlife (Continued)

will be spring-fall grazing when the livestock are moving through the tract.

The construction of a dam in "No Name Gulch" and possibly one on Willow Creek should not affect the mule deer to a large degree if construction is done during the summer when the deer are generally at higher elevations. The water in the dams is expected to be of good enough water quality that it can be used by wildlife and livestock.

The main road may impede some east/west deer movement through the pinyon-juniper type north of the tract. The main impact may be through deer hit by vehicles while crossing the road. Indirect consequences of development of the tract are increased hunting pressure, poaching, trail biking and snowmobiling.

The effect of habitat loss on small mammals is drastic for the ones living in the proposed disturbed areas, but marginal overall. Species in the avian population will be disturbed, and some will be displaced. If substantial changes in mammalian popualtions occur, changes may also occur in the abundance of certain raptor species. However, the small percentage of habitat to be disturbed relative to the total extent of simlar habitats in the region suggests that local reductions in small mammal numbers should not have

9.9 Fish and Wildlife Plan

.14 Estimated Effects of Action on Wildlife (Continued)

significant consequences on the habitat of wide-ranging raptorial species.

.15 Mitigation

Habitat Conversion. The planned mitigation is based on assumed plant-animal responses and normal weather patterns. If these assumptions change or are found to be different, the mitigation measures may have to be altered to meet the changed conditions. The environmental monitoring plan describes methods to be used to verify success of mitigation. At this time, the following is our planned course of action.

The main thrust for mitigative measures will be to provide alternative habitat for wildlife displaced by the activities of Tract C-b by increased production on the tract and off-tract areas to the north of the tract across Piceance Creek. These south-facing slopes are extremely important to wintering mule deer, and they lie within a known deer concentration area. Habitat improvements outlined in the Piceance Creek Habitat Mitigation Plan (H.M.P.) will also be of mitigative value. These are: Piceance Creek willow planting, 1/2 mile stream for trout; Stewart brush beating and seeding, 75 acres for elk, deer and cattle. The priority given thse projects are low for the Piceance basin, but with development of Tract C-b, these

).9 Fish and Wildlife Plan

.15 Mitigation (Continued)

projects would have high priority. Funding these projects, or direct involvement in carrying them out are planned. As with improvements to the north of the tract, H.M.P. Projects will have to be studied in cooperation with the BLM, DOW, OSO, and the lessee for ranking as to priority and amount necessary for mitigation. Habitat improvements will be goal-oriented toward increased browse for deer and forage for livestock to the extent that at least the estimated loss of habitat for 150 deer and 235 A.U.M.'s cattle are mitigated. Critical early spring deer habitat near Piceance Creek and south-facing slopes above Piceance Creek are recognized as highly important planning areas.

One mitigation measure already in progress is a sagebrush modification project in two draws north of the Piceance Creek Highway. Approximately 100 acres of mature bottomland sagebrush (varying 5 to 10 feet in height) was chopped using a brush cutter. Both areas were reseeded with grass and browse species. Depending upon the successfullness of increased forage production and increased use by livestock and wildlife, brush beating may be used as a habitat improvement technique in other sagebrush draws. Alternatives to sagebrush modification projects listed from the Piceance Creek H.M.P. are on tract areas in Scandard

9.9 Fish and Wildlife Plan

.15 Mitigation (Continued)

and West Stewart. Also, larger areas are found both north and south of the tract.

In addition to the sagebrush draws north of the tract, there are approximately 1500 acres of pinyon-juniper for possible chaining between Willow Creek and Big Jimmy Gulch. Potential chained areas will be broken down into small irregular blocks of 40 acres or less to simulate natural parks. It may be necessary to fertilize the chained areas to increase forage production and palatability. Fertilization may be a rapid method to improve habitat, whereas, chaining returns benefits over a longer time. To insure that the fertilizer is not tied up by microbial organisms in the litter, instead of being made available to the plants, some of the slash may have to be burned or removed.

Several other proposed mitigative measures include; prescribe burnings in old chainings to increase the rate of litter breakdown; fertilizing and reseeding to increase herbaceaus production; and fencing and providing water to help distribute livestock and get better range utilization by the livestock and wildlife.

Reduction in cattle A.U.M.'s may be mitigated to some degree by sagebrush modification, but it would be desirable to improve

.9 Fish and Wildlife Plan

.15 Mitigation (Continued)

the habitat of the drainages north of the tract. A large sagebrush greasewood flat exists on Piceance Creek north of the tract, which is suitable for improvement. The flat is on deeded land. Agreement will have to be reached with the land owners. The area should be cleared of brush and seeded to a highly productive wheatgrass. If no water was available, a dry land pasture would be much more productive than the existing vegetation. The early green feed will also benefit the deer.

For the benefit of both wildlife and livestock, several water projects are planned. With the exception of Piceance Creek, there are very few places to water for wildlife and livestock on or near C-b Tract. Although not planned as a mitigation project, the proposed dam in East "No Name" and possible Willow Creek Dam should provide early summer and fall water for wildlife and livestock. In addition however, if the water is found to be unsuitable, the area will be fenced. The dam in Willow Creek would probably be large enough to consider stocking with fish and would enhance the aquatic habitat of the area. A stock tank for wildlife and livestock will be placed below our sewer treatment plant, which will produce approximately 5 gallons per minute of good water. Two stock tanks (made up of large tires) were placed out on tract in 1978 to provide water in the spring and fall.

9 Fish and Wildlife Plan

.15 Mitigation (Continued)

In addition, several other stock tanks and wells are planned in areas on or near the tract.

In chained areas, the debris left will provide cover for small mammals. Small mammals preferring pinyon-juniper will be reduced at the expense of those preferring grass and brush types. Rabbits will benefit by the chaining and sagebrush modification. Scattered small islands of pinyon-juniper will be left in chained areas to reduce the impact on birds preferring tree-types for nesting.

Mitigative measures will be scheduled to produce the mitigative benefit in coordination with development of the tract. Many of the mitigative measures will be initiated in the first five years of project. To maximize success of the habitat enhancement program, the Lessee will attempt to reach cooperative agreements with the Bureau of Land Management on livestock grazing management during critical phases of the improvement program

Habitat Restoration. The Erosion Control and Revegetation Plan (Section 9.10) discusses contouring and revegetation of the processed shale pile, and other disturbed areas. This plan will address itself solely with the type of vegetation desired on the processed shale pile. It is not desirable to plant the entire

9.9 Fish and Wildlife Plan

.15 Mitigation (Continued)

processed shale pile with the same vegetation mixture. The purpose is to create different vegetative types and thus maximize both vegetative production and edge effect.

Vegetation-type will be planned for as follows: The south slopes will be planned for a grassland-type using adapted native and introduced species. This will provide the early green feed that is heavily used by deer.

West slopes will be revegetated with a mixture of grasses and shrub types that are adapted to the site. Saltbrush species and other more drought-tolerant shrubs will be emphasized. The north and east slopes will emphasize the more desirable shrubs, such as bitterbrush and mountain mahogany which will provide winter feed of good quality.

The level top will emphasize cool season grasses and desirable shrubs. The emphasis will vary, depending whether the aspect is northerly or southerly.

Three species, such as pinyon-juniper, will be planted over the whole area in general in such a manner that the other vegetation types form pockets within the P-J type. The purpose is to provide travel lanes for wildlife moving between types. This will mean fingers of P-J running through the disposal area.

9.9 Fish and Wildlife Plan

.15 Mitigation (Continued)

These fingers should be 100-200' minimum width. The idea is to have them dense enough that vision is blocked when viewed from the side. If it is possible to see clear through the finger, it will not provide enough cover to be used by wildlife for travel lanes.

.16 Possible Problem Areas

Vehicle-Wildlife Collisions. Unless preventive actions are taken, increased incidences of collisions between deer and vehicles will occur from increased traffic, resulting in the risk of injury or loss of human and animal life, and vehicular damage. Mass seasonal migrations of deer across highways and the daily movements of many deer between cover and foraging areas accentuate the problem in the tract area.

The Lessee's objectives for preserving wildlife are: 1) minimization of deer mortality resulting from deer-vehicle collisions; 2) reduction of the risk of accidents causing injury to humans resulting from deer-vehicle collisions; 3) minimizatin of the economic costs of collision prevention systems and economic losses resulting from collisions; and 4) cooperation with regional programs for deer-vehicle collision prevention.

9.9 Fish and Wildlife Plan

.16 Possible Problem Areas (Continued)

In conjunction with the Division of Wildlife, the Lessee has been monitoring roadkills along the Piceance Creek Highway since 1977. Deer mortalities are recorded according to location, age, sex and animal condition. To help reduce the roadkills, free bus service to work from Meeker and Rifle is provided to the employees. The employees are made aware of the potential deer/automobile collisions through signs, handouts and lectures. Traffic counters have been installed to estimate the traffic load on the Piceance Creek Highway.

If deer-car collisions beocme a problem, a cooperative venture will be started with the Division of Wildlife to help remedy the problem. The use of deer fencing, underpasses and other feasible methods will be considered. The intent of the fencing is to use as little fencing as necessary to achieve protection of deer and humans, while still assuring that migration and daily movements of deer and other wildlife species will not be hampered. Procedures will be followed in locating and designing fences to minimize their visibility. Principal deer movements follow north-south paths. To permit such movements, underpasses will be located at appropriate positions along the Piceance Creek road deer barrier. The exact method or methods used to solve the deer-car collsion problem will be determined at that time.

9.9 Fish and Wildlife Plan

.16 Possible Problem Areas (Continued)

The tract access road has seemed to have little affect on the deer at this time. To reduce the chance of deer-vehicle collisions on the tract, maximum permissible vehicle speed on secondary roads will be 25 mph.

Wildlife Disturbances Resulting from Human Activity. The presence of people and companion animals moving about on foot may have a greater effect upon the distribution and behavior of wildlife than the presence of buildings and vehicles. This type of wildlife disturbance will occur during all periods of development.

Several methods will be used to minimize unnessary disturbance of wildlife because of the presence and movement of humans and their companion animals: 1) An information and education program for workers on adverse effects of extra vehicular activity and wildlife harrassment; 2) restriction of extra vehicular activities by personnel; 3) limitation of activities in critical areas; 4) limitation or control of parking along roads controlled by the Lessee; and 5) control of pets.

The proposed control strategy includes informing all construction and operating personnel of their responsibilities with respect to fish and wildlife laws, and cooperating actively with

9.9 Fish and Wildlife Plan

.16 Possible Problem Areas (Continued)

law enforcement personnel. The information program will include posting bulletins in all personnel offices, change rooms and recreation halls, and distributing relevent regulations to all employees. Wildlife conservation officers will be allowed ready access to the property. The promotion of good attitudes toward wildlife will also be fostered by supporting sports, nature and conservation groups. Current game, fish and related regulations will be posted on bulletin boards and brochures regarding these regulations will be distributed to all employees. Also, harassment of wildlife, excessive land disturbance; or, in general, actions which detrimentally effect the environment will be policed carefully.

Access Management. Continued provision for public access to the tract to allow appropriate opportunites for harvest and non-harvest uses of wildlife resources is a requirement of Section 4(A)(4) of the Stipulations. Public access requires careful supervision because of the difficulties in maintaining adequate security and safety. The public will be allowed access to and through those parts of the tract which are not critical to plant operation or do not pose health and safety problems. It should be noted that excessive access might adversely affect wildlife species.

Proposed policies include continuing to provide public access to the tract at a level comparable to that during the baseline

.16 Possible Problem Areas (Continued)

period, where such access is compatible with security and safety. Procedures for implementing these policies include fencing of critical plant-mine complex areas, the use of security guards and prohibition of firearms in areas where they would create a safety hazard. Areas where machinery is operating on the disposal pile will be restricted. Also, no vehicle traffic will be allowed on the shale dipsosal piles where revegetation is underway.

Secondary Effects Resulting from Growth in Human Population. It is recognized that development and operations on the tract will contribute to the human population growth of Rio Blanco and Garfield counties, and will generate secondary influences. Secondary effects may have negative effects upon wildlife, such as the modification of wildlife habitats for housing, business and transportation, the diversion of water from current uses to commercial and industrial uses, and wildlife disturbances resulting from increased outdoor recreation. These effects will occur during all periods of development.

The Lessee's objectives in attempting to deal with the increase in local population include formulation of a policy of cooperation with other firms, agencies, organizations and individuals to coordinate wildlife management programs throughout

.16 Possible Problem Areas (Continued)

the region. This policy will be implemented through personnel management and planning. Methods for implementation could include the use of various media and liaison with the OSEAP, other government groups and citizens' groups.

Erosion in Terrestrial Habitats. Site development and construction activities, including roads and pipelines, can result in erosion which affects contiguous habitats and reduces their ability to support vegetation and wildlife.

The Lessee's objectives in mitigating erosion include: 1) minimization of areas to be disturbed; 2) minimization of the length of time that any area will be subject to disturbance; and 3) restoration of natural habitats on disturbed areas.

Methods of erosion control are addressed extensively in the Erosion Control and Surface Rehabilitiation Plan. Control of construction procedures by inclusion of environmental provisions in construction contracts on the tract will be standard policy.

Modification of Aquatic Habitats. The destruction or modification of aquatic habitats on the tract is expected to be negligible, due to the lack of flowing waters. Habitat modification may result from site preparation, stream crossings, diversion of

).9 Fish and Wildlife Plan

.16 Possible Problem Areas (Continued)

natural ephemeral water courses, or inundation of a natural stream by a reservoir. The disposal site for processed shale will be located in Sorhum Gulch, where natural stream flow seldom occurs.

The Lessee's objectives for minimizing damage to aquatic habitats and procedures to avoid damage are set forth in the Water Pollution Control Plan and include: 1) minimizing areas of aquatic habitats to be modified; 2) promptly correcting water contamination problems; and 3) using construction procedures to avoid siltation or direct harm to aquatic habitats.

Erosion and Siltation Affecting Aquatic Habitats. Erosion may result in destabilizing conditions in aquatic habitats, and increasing turbidity and siltation. Modification of vegetative cover adjacent to aquatic systems or water courses is the primary cause of increased erosion. The resulting increases in turbidity and siltation rate are generally detrimental to aquatic organisms, especially benthic macroinvertebrates and fish. High levels of turbidity can limit the productivity of algae and aquatic macrophytes, the primary producers in aquatic ecosystems. All site development and construction activities will probably contribute to this problem. Erosion control will be accomplished through the use of methods given in the

9.9 Fish and Wildlife Plan

.16 Possible Problem Areas (Continued)

Erosion Control and Surface Rehabilitation Plan. The basic objectives are to: minimize erosion and siltation; and, where this is unavoidable, to mitigate adverse effects on aquatic habitats.

Sedimentation ponds will be located on drainages which transport waters from construction zones in order to remove suspended solids before discharge.

Based upon observations made during the baseline investigations, ponds in the area are clear and turbidity is very low. Rapid revegetation of road banks and other disturbed areas, and the confinement of processed shale to one drainage basin which will have no discharge to Piceance Creek, should effectively minimize turbidity and siltation problems.

Water Pollution Affecting Aquatic Habitats. The Stipulations regarding Federal and State water quality standards prohibit discharges to any stream or tributary, unless such discharges meet State and Federal water quality standards. Thus, no direct water pollution from development activity is expected. Accidental discharges resulting in stream pollution are addressed in the Spill Prevention Control and Counter-Measure Plan (Section 9.3).

9.9 Fish and Wildlife Plan

.16 Possible Problem Areas (Continued)

Reduction in Ground-Water Discharge Affecting Terrestrial and Aquatic Habitats. Modification of terrestrial and aquatic habitats will result, if a significant reduction in springs or seeps occurs. Impacts include the possible reduction in flow of a portion of Piceance Creek and reduction in water levels of ponds. Some terrestrial habitat, notably the greasewood and riparian communities, depends to some extent upon springs and seeps as a source of water. Irrigated pastures along Piceance Creek depend upon managed ground-water discharge since Piceance Creek is largely spring-fed. Consequently, changes in ground-water availability can influence distribution and composition of these communities, as well as their capacity to support wildlife.

Mine dewatering could have local and possibly more extensive effects upon ground-water discharge. Data and information derived from the Lessee's hydrologic testing program indicate that dewatering operations can be conducted in a manner that will have little effect on springs and seeps in the vicinity of the tract, i.e. through reinjection and water augmentation. The effects of dewatering will be monitored carefully and remedial action taken if detrimental effects occur. Such action could include sealing and grouting the mine shafts to reduce the amount of ground water entering the shafts and providing supplemental water for Piceance Creek. The flow of Piceance

.16 Possible Problem Areas (Continued)

Creek will be maintained as necessary principally by flow augmentation.

Effects of Air Pollution. Plant facilities will be designed to meet Federal and State air quality standards, which have been promulgated to protect the public health and welfare. Air pollution-related effects are addressed in the Air Quality Control Plan (Section 9.1).

Effects of Noise. Noise from road travel, construction and plant machinery, and processing units may affect the behavior and distribution of wildlife, such as deer. However, deer are known to acclimate rapidly to repetitious or familiar noises. Raptors are sensitive to loud noises, especially during the nesting period.

The objective of the Lessee is to minimize potential consequences of noise on wildlife species. Noise control plans which will serve to mitigate these potential effects are the same as those proposed for humans and are described in the Noise Plan (Section 9.8).

.17 Contingency Planning. Throughout this plan, reference has been made to other plans by the Lessee, also contained in this chapter, for minimizing and controlling specific types of effects on

9.9 Fish and Wildlife Plan

.17 Contingency Planning (Continued)

on wildlife and habitat. These environmental control plans and programs include the following:

- Air Pollution Control
- Water Pollution Control
- Noise Pollution Control
- Protection of Objects of Historic or Scientific Interest and Aesthetic Values
- Fire Prevention and Control
- Health and Safety
- Overburden Management
- Processed-shale Disposal
- Disposal of Other Wastes
- Erosion Control and Surface Rehabilitation Plan, Including Demonstration of Technology for Revegetation of Disturbed Areas
- Oil and Hazardous Materials Spill Contingency Plan
- Off-tract Corridors

It must be recognized that an unforeseen accident or natural disaster could result in the loss of fish or wildlife habitat. These could include failures of air or water pollution control equipment or spills of hazardous materials. If such an event were to result in significant destruction or damage to

9.9 Fish and Wildlife Plan

.17 Contingency Planning (Continued)

habitat, the Lessee would attempt to restore the habitat directly affected through the use of planting, seeding, fertilizing and restocking, if necessary. These procedures would be undertaken as soon as possible after the occurrence, and would proceed in accordance with mitigating plans submitted to and approved by the OSO. Mechanisms for reporting and responding to such unforeseen occurances are addressed in various environmental control plans elsewhere in this chapter.

.18 Summary

This plan was devised as a cooperative venture among the OSO, BLM, DOW, and the landowners affected. It is designed to supplement their plans; while, at the same time, reducing the impact on tract habitat and fauna. After completion of each phase of the project, target animal response will be monitored to insure the desired results are obtained. If the desired result is not obtained; we will, in cooperation with the other agencies, attempt to determne the cause and amend the plan to incorporate the changed situation and goals. If unexpected circumstances or changes arise, the OSO will be notified in timely fashion.

9.10 Erosion Control Plan

.1 Introduction

The scope of the erosion control plan includes the control

.0 ENVIRONMENTAL CONTROL PLANS

.10 Erosion Control Plan

.1 Introduction (Continued)

of wind and water erosion by utilizing appropriate construction, operational and reclamation methods to minimize the short and long term environmental impacts of the development and eventual abandonment of the C-b Tract. This plan will necessarily evolve with the development of the tract and the regulatory policy changes that will occur over the long life of such a project.

This section will address the various modes of wind and water erosion and their impact and control on the various disturbed areas of the tract. Approximately 2000 acres of the C-b Tract will be disturbed at the mine support area, surface retort site, utility corridors, material stockpiles and other ancillary facilities. A separate discussion of the proposed reclamation and revegetation techniques will conclude this section.

.2 Wind Erosion Control

Wind erosion in the form of fugitive dust emissions can potentially result from:

- Unpaved roads;
- Disturbed areas under construction;
- Topsoil storage piles;
- Raw shale stockpile; and the
- Processed shale waste pile.

.0 ENVIRONMENTAL CONTROL PLANS

.10 Erosion Control Plan

.2 Wind Erosion Control (Continued)

All construction and operations work will be conducted in accordance with applicable state and federal regulations. Disturbed acreage will be limited to those areas necessary for the preparation of construction of various facilities, and will be scheduled sufficiently close to the actual construction to minimize exposure to the wind. Prior to final or interim revegetation, and for those areas continually disrupted by materials handling activities, the primary control measure will be water sprays supplemented with chemical suppressants when water alone fails to reduce dust to acceptable levels. Emissions from these areas can be reduced by fifty percent with these treatments, which will be continued until sufficient revegetation stabilizes the exposed surfaces. The use of chemical suppressants can reduce emission levels by eighty five percent. Roadways and construction staging areas will be controlled by water trucks equipped with sprays. Permanent roads will either be maintained in this fashion throughout the life of the project or will be paved.

The most critical phase in the erosion plan is the construction period. At these times, exposed cut and fill areas are particularly susceptible to erosion. Other sources of wind erosion will be the raw shale stockpile and the ongoing construction of the processed shale storage pile. Concurrent with these activities,

.2 Wind Erosion Control (Continued)

topsoil will be stripped and stockpiled for the permanent revegetation of the processed shale pile.

The raw shale stockpile in Cottonwood Gulch will be developed to contain the excess material generated prior to full-scale surface retorting by mid-1990. (See Section 7.1) The maximum dimensions will be reached by July 1990, and depletion of the pile is projected by 2011. As the pile increases in size, topsoil will be stripped ahead of the advancing face and stockpiled for use in later revegetation. The working face will be restricted to no more than 15 acres. Water sprays will be employed as needed to minimize fugitive dust, although the shale itself should be coarse enough to minimize wind erosion potential. An environmentally acceptable chemical agent will be used to further stabilize the raw shale pile. Topsoil generated during the construction of the raw shale storage pile will be stored on the southeast side of the ridge between Cottonwood Gulch and Scandard Gulch (see Drawing EM-127). This topsoil storage pile will also be controlled by water sprays and revegetated to control dust.

The largest single disturbance during the life of the C-b Tract project will be the construction of the processed shale disposal pile, disturbing some 1,346 acres. The disposal pile will project an average 240 feet above the surrounding ridges

9.10 Erosion Control Plan

.2 Wind Erosion Control (Continued)

of Sorghum Gulch, and thus will not be fully protected from the wind by the topography.

An alternative to this configuration would be to place the processed shale off-tract to the south in the head of Sorghum Gulch. This would not only provide a larger disposal area and thereby lower the height of the pile, but would provide the additional benefit of filling in the upper tributary area and reducing the effects of surface runoff on the disposal area. At present, this alternative is being considered and is contingent upon legislative approval. For the purpose of this plan, however, it will be assumed that all of the processed shale will remain on the tract.

As with the growth of the raw shale stockpile, the processed shale pile will advance in a northerly direction with topsoil being stripped ahead of the pile. Drawings EM-119 thru EM-128 show the chronological progression of the pile. The working face of the processed shale pile will not exceed 50 acres.

As the top surface of the processed shale reaches the final elevation of 7140, the previously stockpiled topsoil will be replaced and revegetation begun. The procedure of simultaneous reclamation and processed shale pile construction will be supplemented with water sprays at active pile areas when necessary to control fugitive dust emissions.

9.0 ENVIRONMENTAL CONTROL PLANS

9.10 Erosion Control Plan

.3 Water Erosion Control

As with wind erosion control, the most important consideration in the control of water erosion is that of planning and scheduling. Excavations required for the construction of the various mine and process facilities will be scheduled sufficiently close to actual construction to minimize exposed areas. In addition to this fundamental control, various construction techniques will be employed to minimize the effects of water on exposed surfaces. These on-site controls will be backed up by additional controls off of the disturbed areas to contain the erosion products on the tract itself. Whereas on-site erosion control practices are designed to prevent soil particles from being detached, the off-site sedimentation control involves using techniques that will prevent the detached particles from leaving the C-b Tract and entering Piceance Creek.

Proper storm water erosion control will be accomplished by the application of one or a combination of the following techniques:

- Diversion of runoff;
- Reduction and detention of runoff;
- Proper handling and disposal of concentrated flows; and
- Diversion of upslope drainage.

These techniques are currently being employed at the mine support and surrounding areas, and will continue on into future development.

9.0 ENVIRONMENTAL CONTROL PLANS

9.10 Erosion Control Plan

.3 Water Erosion Control (Continued)

Diversions will be constructed to either direct upstream surface runoff around or through downstream disturbances, or to convey runoff from disturbed areas to sedimentation ponds for proper disposal. The diversion structures employed will be a combination of ditches, culverts, terraces and earth dikes.

The runoff from the eastern face of the processed shale pile will be diverted from the Stewart Gulch drainage area by a ditch on the ridge separating Sorghum Gulch from Stewart Gulch. The flow will run in a northerly direction and discharge into the Sorghum Gulch downstream of the spent shale pile, and will ultimately flow through a sedimentation impoundment at the northern boundary of the tract. In an effort to reduce surface runoff, interceptor ditches will be constructed on the processed shale pile to retain water that will assist revegetation. Graded rock check structures will be placed in the drainage channels to temporarily impound the flows and settle out the sediments. This technique is currently being implemented at the mine support area near the topsoil and rock storage piles.

The current plan of limiting the disposal of the processed shale to the tract will leave 790 acres of the Sorghum Gulch drainage area upstream of the storage pile. The runoff from this acreage will be diverted under the processed shale pile via a concrete

culvert. The processed shale disposal area drainage scheme is further explained in Section 7.2. The final design of the processed shale drainage system will be submitted to the OSO as a DDP technical update as soon as it is available.

Reduction and detention of runoff from disturbed areas will consist of grading and shaping the soil surface to trap rainfall, break up surface airflow, and afford protection to wildlife. This technique will be especially significant on the large surface area of the processed shale pile. A properly roughened and loosened soil surface will enhance water infiltration, slow the movement of surface runoff and benefit plant growth. Common techniques of roughening the surface include tracking, scarification and furrowing.

In addition to surface preparation, another means of reducing the rate of runoff from the disturbed areas will be that of reducing slope lengths and minimizing gradients. Benches will be constructed on the outslopes of all storage piles to shorten exposed slopes and thereby reduce erosion rates. This technique will be followed on all cut and fill slopes. Benches will have a reverse slope back toward the hill, and will collect and discharge intercepted water into engineered diversion ditches.

9.10 Erosion Control Plan

.3 Water Erosion Control (Continued)

The concentrated flows produced by the previously discussed erosion control techniques will be handled by rock riprap, rock check dams and culverts where applicable. These structures will dissipate the flow energy and shield sensitive areas from the erosive impact of the water. The primary means of handling the concentrated flow will be the sedimentation ponds themselves; these will also be the final barrier against the sedimentation of Piceance Creek. These two major impoundments will be located in Cottonwood and Sorghum Gulches, and will be zoned-earth embankments capable of containing a 100-year, 24-hour storm. All applicable state and federal dam regulations will be considered in the design of these structures, with the most stringent sections of each being adapted as design parameters. In addition to their primary function as gravity settling impoundments, these structures will also provide the option of chemical treatment if any leachate from the raw or processed shale piles or other contaminants pose a problem.

.4 Reclamation Plan

Cathedral Bluffs will rehabilitate lands disturbed during the development of oil shale resources on the tract in a manner consistent with good ecological practices, economic feasibility and practical land use considerations. Lease Stipulation 11.A requires that "reclaimed land [be] in a usable non-hazardous

condition such that soil erosion and water pollution are avoided or minimized". To accomplish these goals, a revegetation plan has been developed to:

- stabilize and control erosion on distrubed surfaces by using proven plant materials;
- support animal populations at least as extensive as those presently on the tract;
- coordinate the natural processes of ecosystem recovery which occur independent of man by using the best available management practices; and
- assure compatibility with existing adjacent undisturbed natural areas.

The proposed post mining land use will be the former use - rangeland and wildlife habitat. The guidelines presented in this plan will apply specifically to the two types of revegetation which are important on the tract: 1) the reestablishment of plant cover on sites disturbed during the exploration and development phases of the project with soil-like material removed from the original disturbance site. The area will be reclaimed as nearly as possible to the original contours and then seeded. (2) vegetation of processed shale after the retorting operation begins. Soil and soil-like material from shale disposal areas will be removed and spread over the shale in a 12 to 18 inch layer as a plant growth medium.

.4 Reclamation Plan (Continued)

Major types of sites requiring revegetation of disturbed soils include abandoned drill pads, access roads, mine and plant sites, support facilities, process areas, raw shale storage area and other cleared support sites, for a total of 68 acres. The processed shale disposal embankment will cover 1,346 acres. The development of revegetation techniques will be one of the major achievements of the Prototype Oil Shale Leasing Program. All techniques used will also be evaluated to determine their suitability in establishing vegetation for the support of existing animal populations.

According to the C-b Tract Lease, the capability of revegetating disturbed areas must be demonstrated. A program to obtain the required technology must be successful by the tenth lease year. This plan addresses the overall approach and strategies selected to meet this goal. Revegetation activities will fall into two major categories: 1) planning and design; and 2) implementation. The planning and design category includes the formulation of topsoiling and planting techniques, development of methods for evaluation of site success, and the integration of baseline data and other pertinent information into initial plans and later program modifications. The implementation category includes site preparation, planting, maintenance, and the evaluation of site success.

9.0 ENVIRONMENTAL CONTROL PLANS

9.10 Erosion Control Plan

.4 Reclamation Plan (Continued)

Responsibility for planning, design and implementation will be shared by the staff and field personnel who design the plan specifics; integrate the plans with other management plans, the baseline studies and current data; and coordinate the activities with the Oil Shale Office (OSO), the Bureau of Land Management (BLM) and the Mined Land Reclamation Board; and finally, implement and evaluate the Surface Rehabilitation Plan.

Rangeland and wildlife habitat is the proposed post mining use of C-b following approximately 40 years of oil shale activity. Because of the importance of C-b to wildlife in the area (the largest migrating mule deer herd in the nation winter near and on C-b), rangeland was chosen as the best ultimate use. In line with BLM's multiple use goal, the resulting rangeland would be useful for wildlife habitat, livestock production, recreation, timber, watershed minerals or oil and gas development. The majority of the surrounding land is presently used for rangeland by the BLM. Smaller areas along Piceance Creek are used for agriculture, primarily hay production by cattle ranchers. This reclamation plan was developed in cooperation with the Division of Wildlife, BLM, and the Oil Shale Office and will be implemented in coordination with the Piceance Basin Wildlife Habitat Management Plan.

9.0 ENVIRONMENTAL CONTROL PLANS

9.10 Erosion Control Plan

.4 Reclamation Plan (Continued)

All reclamation shall be completed within five (5) years from the date C-b informs the Mined Land Reclamation Board that the ultimate surface has been created for reclamation. The reclamation plan is initiated the first fall following the final disturbance of an area.

Grading. Grading shall be carried out so as to create a stable topography. The majority of slopes will be a maximum of 4:1 (horizontal to vertical ratio).

The permanent slopes created on the raw and processed shale pile embankments will be 4:1 or less. Compaction will result from mechanical compactors and dozers which contour and shape the pile. In summary, stability is insured by gentle slopes and compaction. Other affected areas will have 2:1 or less slopes; these include gatehouse, ancillary area, oil/water separation area, product fuel storage area, process area and facilities, mine support area, batch plant area, process area and explosives area. Because these areas are not permanent, they will have 2:1 or less slopes, which will minimize surface area disturbed. Since revegetation is difficult on 2:1 slopes, rock will be used to temporarily stabilize the surface of these areas. Coarse rock will cover the slopes; asphalt and gravel will cover the level surfaces around buildings and assorted structures.

9.0 ENVIRONMENTAL CONTROL PLANS

9.10 Erosion Control Plan

.4 Reclamation Plan (Continued)

Eventually (approximately 40 years or until operations are terminated), these other affected areas will be recontoured to original contours, and reclaimed.

Water. C-b will be in compliance with applicable Colorado water laws governing existing water rights, and applicable Federal and Colorado water quality laws and requlations.

Runoff control from affected areas will be accomplished by use of siltation impoundments. All impoundments will be inspected at least twice a year, and if suitable, sediment cleaned out and removed to the processed shale disposal embankment for use as plant growth medium. After the operational life of the project these siltation impoundments will be left in place for a habitat improvement as watering ponds. Other runoff control measures are prompt stabilization of affected areas with either rock or vegetation.

Topsoiling. Topsoil or soil-like material will be removed from cut and fill areas and stockpiled for later use as a 12 to 18 inch plant growth medium. Live trunks and limbs over four inches in diameter will be bucked to firewood size and stacked where it can be safely removed by the public. Live tree limbs less than four inches in diameter will be chipped and broadcast over surrounding undisturbed areas. Dead slash, stumps, and live brush will be

cleared from construction sites to the downslope perimeter of cut and fill areas for stabilization and aesthetic value. This material will be arranged in non-continuous windrows. An important aspect of brush removal is that topsoil or soil-like material should not be lost in the windrows. Brush clearing equipment will raise their blade until little soil is removed. The amount of brush which can not be windrowed without soil loss will be removed with the topsoil. Brush will add organic matter to the topsoil which will enhance the plant growth characteristics.

Topsoil will be transported and deposited with scrapers; dozers will shape the enbankment. The processed shale topsoil stockpile area will be located in the advance fill area. Therefore, no additional area will be used to store topsoil for the disposal area. An exception is: the topsoil material from year 40 from the disposal areas which will be used for topsoiling the areas stablized by mechanical methods (the support area, process area, administration area, etc.). The topsoil from the mechanically stabilized areas stored in year 1 will be used on the disposal area for years 40 and 41.

Potassium is generally deficient (<100 ppm) in the topsoil, possibly because of pH value in excess of 7.0, also high lime percentages inhibit phosphorus availability. Phosphorus,

9.10 Erosion Control Plan

.4 Reclamation Plan (Continued)

potassium, nitrogen, copper, zinc, iron and manganese are low. Therefore, the fertilization rate will be 80-100-50 (N-P-K) with a trace of Zn, Cu, Mn, Fe (N-80 lbs/acre, P-100 lbs/acre, K-50 lbs/acre with trace elements). Areas to be fertilized will be tested and trace nutrients adjusted accordingly. Fertilizer will be applied in the fall after the first growing season with standard farm fertilizer broadcast spreaders. Fertilizer application in the fall after the first growing season is planned so weed competition is not encouraged the first year when weeds are generally the most competitive. Establishment of seeded species will not require fertilization before the first growing season.

Revegetation. Rangeland and wildlife habitat are the proposed land uses for all affected areas. Seeding will be done with Rangeland drill, with a packer unit. Seeding will be done in September to November. Transplanting will be done in April to June. Mulching will be straw "crimped in" at the rate of two tons per acre. Weed control will consist of mechanical methods, disking in spring and fall before seeding. Fertilizer will be the same as that discussed in the topsoiling section. Evaluation three years after reclamation will be determine if the areas are ready to be returned to grazing use. This will be determined by meeting all the following requirements:

9.0 ENVIRONMENTAL CONTROL PLANS

9.10 Erosion Control Plan

.4 Reclamation Plan (Continued)

productivity at least as much as the existing surrounding vegetation (2) ground cover at least as great as existing surrounding vegetation (3) reclaimed areas large enough that hervivores will not damage seeding (around 500 acre blocks) (4) reclamation specialist and regulatory agencies are satisfied the area is stabilized and the plants are vigorous enough to withstand grazing. At this time the four foot animal control fence will be removed.

9.11 Subsidence Plan

.1 Introduction

This section presents a plan for field monitoring of subsidence associated with the underground mining/in-situ retorting of oil shale. In general, the field proceedings involve two general areas of activity: subsurface instrumentation and surface procedures. Subsidence from initial in-situ rubblization is not anticipated. However, as panels become larger with less pillar volume, the chance for some subsidence increases.

.2 Subsurface Instrumentation

Subsurface instrumentation will be installed on selected support pillars in the mine and along entries adjacent to the pillars. The precise placement and number of instruments will depend on the final mine plan. These measurements may assist in identifying potential hazards for the miners.

9.11 Subsidence Plan

.2 Subsurface Instrumentation (Continued)

The exact number of each instrument type will be determined by the size of pillars and variation of geologic formation.

.3 Surface Subsidence

A surface subsidence network will be installed to provide adequate subsidence information for accurate data collection, analysis, and subsequent interpretation. In general, one row of subsidence monuments will be installed the length of the mining operation and another row perpendicular to this row.

Each row will be extended past the last projected row a distance of 1.4 h (h = depth) beyond the last row. In addition to this network, four turning points will be constructed at strategic locations outside the projected area of influence where they would provide maximum visibility of the various rows of subsidence monuments. The location of those surface monument sites will be located using a theodolite and measuring.

9.12 Health and Safety Plan

.1 Introduction

The oil shale employee will be exposed to occupational safety and health hazards. Many of these exposures are not unique to oil shale, but to any hard rock mining and oil processing activities. They could include rock falls, dust, noise, mine gases, explosions, fires, and to a limited degree, exposure to

9.12 Health and Safety Plan

.1 Introduction (Continued)

organic feedstocks and semi-refined products. Although the oil shale industry in the United States is in its early stage of major development, detailed data in the epidemeology of human contact to oil dust and process byproducts exists in two studies. The Paraho workers health study concluded that the greatest health risk to oil shale workers was mining accidents. The NIOSH study concluded that no major health effects could be attributed to oil shale activities. Any potential synergistic effects of traditional mining and oil processing byproducts will be addressed through the company medical surveillance program. Therefore, Cathedral Bluffs oil shale project will rely on implementation of programs specified under the following regulations:

- Federal Mine and Safety Health Amendments 1977;
- Toxic Substance Control Act 1976 (only as it applies to toxic substances not covered under other federal legislation).

.2 Health and Safety Hazards

The oil shale operation will be divided into discrete areas which have more or less unique safety concerns. These areas are:

- mining (flooding, roof falls, explosion/fires, electrocution, vehicular traffic and mining equipment), and
- retorting and refining (explosives, fire and heat, electrocuti and handling hot liquids).

From a standpoint of health hazards, the following areas will be used:

9.12 Health and Safety Plan

.2 Health and Safety Hazards (Continued)

Mining - concerns in this area include diesel emmissions, possibility of oil shale dust explosions, silica dust, potential exposure to trace elements, noise, contact dermatitis, heat/cold effects, and high altitude effects.

Retorting and Refining - concerns in this area include the potential exposure to several forms of hydrocarbons and inorganic gases. These have been solved in traditional oil refineries by use of air-tight pipes and leak detectors. In addition, trace metals will be present, such as vanadium, arsenic, nickle and cobalt. Numerous studies have recently been initiated to assess the health hazards of oil shale retorting to workers and their findings will be reviewed.

Cathedral Bluffs oil shale project plans to control and mitigate health and safety hazards by using the following techniques:

- Using pollution control technologies described in the Air Pollution Control Plan, Spill Contingency Plan, and Noise Control Plan.
- Provide worker training programs for both new and existing employees identifying hazardous areas and presenting safety manuals to prevent exposures.
- Incorporating safety features in the design of the mine and processing facilities to reduce the exposure potential.
- Institute health and workplace monitoring programs to ensure the opportunity for early diagnosis of any health problems. This will include computerized record-keeping per present company program.
- Continue monitoring R & D findings which may alter worker exposure (e.g. NIOSH or OOSI toxicology program).
- Provide Safety/First Aid Manual specifically prepared for the mine or retorting facility addressing all potential exposure to hazardous material and a step-by-step outline to control any exposure.

9.12 Health and Safety Plan

.2 Health and Safety Hazards (Continued)

Cathedral Bluffs recongnizes the importance of occupational and environmental health and safety in the development of an oil shale industry. Anticipation and planning, especially in the early phases of development, will guide this effort to minimize health and safety risks.

9.13 Off-Tract Corridors

The off-tract corridors were planned to minimize environmental damage and provide sound planning for off-site activity. Reviewed below are pertinent lease requirements, applicable laws, and regulations incorporated into the Lessee's plans for compliance with future construction.

Section 2(A) of the Stipulations requires that the Lessee provide corridor plans for pipelines and utilities for approval by the OSO. Each plan will include probable major design features and plans for protection of the environment. The Lessee will make use of multi-use pipeline (existing and planned) as practicable.

Environmental protection measures for construction and operation of the pipeline include construction practices, spill measures, shut-off valves, emergency procedures, cathodic protection, insulation and corrosion protection, waste disposal and cleanup, hydrostatic testing, maintenance and leak detection. These are discussed in detail in Section 8.3 II.C and the Oil and Hazardous Materials

9.13 Off-Tract Corridors

Spill Contingency Plan. Section II.C. also describes the ditching and backfilling procedure that will be followed to minimize erosion and protect normal drainage routes. In accordance with recommendations in the scenic evaluation of the corridor, attempts will be made to "ruffle" the edge of the right-of-way to minimize visual impact of the corridor. In addition, attempts will be made where practical to replant some of the shrubs and to save trees. Erosion control and rehabilitation of land in the pipeline corridor will be carried out as described in Section 9.10, Erosion Control Plan, including building fences, culverts, and waterbars according to BLM standards.

Additional lease stipulations include: planning new road construction to avoid unreasonable disruption of existing roads, pipelines, other right-of-ways or major animal migration routes; minimizing disturbance to perennial streams, lakes, and rivers; and planning for regulation of public access and for off-road vehicle use.

Investigations of the approved powerline corridor indicate that a combination of conventional and helicopter construction techniques may be required to complete the proposed construction in accordance with good evnironmental practices. Where temporary construction roads are necessary, they will be located, built and rehabilitated in an environmentally acceptable manner as described in Section II.D.11. Existing roads and trails will be used where feasible. Power transmission facilities have been designed and will be constructed in

9.13 Off-Tract Corridors

accordance with the guidelines set forth in "Environmental Criteria for Electric Transmission System" (UDIA, USDA, 1970). Distribution lines will be designed and constructed in accordance with REA Bulletin 61-10 (Powerline Contacts by Eagles and other Large Birds) and minimize disruption of raptor nesting activities.

9.14 Abandonment Plan

.1 Introduction

Upon termination of the C-b lease, the disposition of all property on the tract will be determined. Section 32 of the lease dictates how the status of all "structures, equipment, machinery, tools, appliances, and materials on the leased lands" will be finalized.

In accordance with the lease requirements, C-b facilities will be decomissioned following the cessation of operations. The following plan is generalized in accordance with current acceptable decommissioning procedures. The primary objective of the plan is to assure the placement of the disturbed area back to a condition similar to the existing environs. This plan does not address reclaiming the processed shale area as this is covered in the Reclamation Plan (Section 9.10).

For ease of presentation, the Abandonment Plan is divided into distinct areas narrowing the operations of the facility. These areas are the surface disturbances associated with the mine and surface retorting facilities. A great deal of the information

9.0 ENVIRONMENTAL CONTROL PLANS

9.14 Abandonment Plan

.1 Introduction (Continued)

provided below will be subject to approval of the land owner and lease holder at the time of abandonment.

.2 Abandonment

Mine-related impacts which require abandonment are:

- service and production shafts;
- ventilation shaft(s);
- retort offgas shafts;
- hydrological monitoring wells (if applicable);
- staging areas;
- mine support facilities;
- access roads;
- utility and pipeline right-of-ways;
- substations and explosive storage areas;
- mine water treatment ponds;
- impoundments; and
- injection and dewatering well sites.

Shafts. These major structures (e.g., headframes) will be disassembled down to ground level and the shafts caved. Additional unconsolidated rock will be used in filling the shaft to the surface. The entire area adjacent to the shafts will be ripped and all non-soil material will be removed to an appropriate disposal site. Following the removal of this material, the area

9.14 Abandonment Plan

.2 Abandonment (Continued)

will be prepared as a seedbed utilizing successful reclamation technology. Reclamation procedures will be applied to reduce wind and water erosion and to provide a self-sustaining vegetation community. Current technology is discussed in detail in the reclamation section.

All non-soil material which has no salvageable value will be reduced in size to pieces suitable for haulage and subsequent burial on site. All salvageable material will be taken to staging areas for appropriate dispostion.

Ground Water Monitoring Wells. As some ground water wells will be left for long-term monitoring of ground water quality, the precise number of wells to be abandoned is uncertain and subject to binding/long-term monitoring requirements. Those wells which will be abondoned will follow this procedure. They will be filled with grout and/or cement, the collar will be cut-off, and the well capped. If three or more wells are within close proximity to one another, some minor seedbed preparation and subsequent reclamation will be undertaken.

Staging Areas. All staging areas associated with the mine and/or in-situ retorting process will be ripped and reclaimed. All non-soil related material will be removed and disposed of in

9.14 Abandonment Plan

.2 Abandonment (Continued)

a manner acceptable to lease requirements. Since this material will be classified as non-toxic, it can be disposed of in a state approved disposal site. The areas will then be graded to a contour which fits into the surrounding environs, then reclaimed in accordance with prescribed guidelines identified in the Reclamation Plan.

Access Roads. The precise dispostion of access roads into the Tract C-b area is uncertain pending review by the OSO and private landowners. As Piceance Creek Basin is a recreational type area, a determination may be made to leave the road to allow further accessibility into the western extent of the basin.

If the decision is made to remove the access roads, then the road will be bladed clean of foreign material. This material (e.g., asphalt) will be trucked away and disposed of. The remaining road bed will be disked to approximately 3 inches to allow root penetration and topsoil will then be applied. This will allow for proper seed germination following application of the seed and mulch. Proper fertilizing rates will be used along with application of short-term watering.

Surface Retort. The greatest visual and surface disturbance is the surface retort and its ancillary facilities (crusher site). CB will commit to disassembling all surface structures saving

9.14 Abandonment Plan

.2 Abandonment (Continued)

those reclaimable materials (e.g., structural steel, vats, etc.) and disposing of the remainder.

Those salvageable materials will be cut into manageable sizes and trucked to areas for final disposition. The disposal material will be divided into two groups: one group will encompass non-toxic waste and the other as toxic waste. Non-toxic material will be reduced to a manageable size then trucked and disposed of in an approved dumpsite. Those materials labeled as toxic will be decommissioned prior to disposal in an approved land fill.

The entire area associated with the retort and ancillary facilities will be sampled for the presence of toxic subtances in the soils from the operation. If such materials are located, the exact extent will be identified further. Soil corings will determine the precise contaminated areas. Contaminated soil will be removed and disposed of in an approved land fill. The entire area will then be regraded to original contour and ripped to 4 inches. Topsoil will then be applied with subsequent reclamation. All areas with high erosion potential will be reclaimed with germination forbs and/or grasses to prevent blowout and water erosion.

9.14 Abandonment Plan

.2 Abandonment (Continued)

This plan has been designed to 1981 acceptable abandonment procedures realizing that in 40 years new procedures will be enforced. The intent today or 40 years from today, nevertheless, is to provide self-sustaining vegetation communities which show minimal impact from oil shale operations.

10.0 ENVIRONMENTAL EFFECTS

10.1 Impact on Land and Vegetation

The primary impact on land associated with the revised DDP will be the increase in the amount of land surface which will be excavated or otherwise disturbed. Approximately 2,027 acres are expected to be disturbed under the proposed revision, as compared with approximately 1,896 acres under the previous development plan.

The major source of land disturbance associated with the proposed revision will be the result of processed shale disposal rather than the disposal of raw shale under the previous plan. Other sources of land disturbance are the surface process facilities, the mine support area, raw shale storage pile, and topsoil storage pile. All disturbed areas are expected to be confined to the C-b Lease Tract area, as was the case with the previous development plan. This may change if off-site storage in upper Sorghum Gulch is permitted by government regulations, the subject of pending legislation.

The amount of land which is expected to be in a disturbed state at any given time during the life of the project is approximately 486 acres (these acres are associated with the Surface Process Facilities, Mine Support, the topsoil storage area, and working face of raw and processed shale piles. This amount is only a slight increase over the approximately 410 acres which were expected to be in the same state of disturbance under the previous plan. The other areas of disturbance, processed shale pile and raw shale storage pile, will be constantly changing as more shale is added and reclamation of the

10.0 ENVIRONMENTAL EFFECTS

10.1 Impact on Land and Vegetation

piles proceeds. Under the proposed revision, as well as the previous plan, all areas which are disturbed will be reclaimed according to accepted and approved reclamation techniques. The reclamation techniques to be used are discussed under the Reclamation Plan, Section 9.10.1.

The locations of land disturbance on-tract will be about the same with the revisions as they were with the previous plan. Cottonwood and Sorghum Gulches are still expected to receive the majority of disturbance (the sites of raw shale storage and processed shale diposal). The increase in acreage will take place mainly in Sorghum Gulch. This means that the same major vegetation types on-tract will be affected. The vegetation type which will receive the majority of the impact will be the chained pinyon-juniper rangeland. An increase in acres impacted is expected in this vegetation type, as well as a slight increase in acres impacted in the pinyon-juniper woodland vegetation type. All acres disturbed, as well as the processed shale disposal pile, will be reclaimed in such a manner that the post-mining land use will be the same as the former land use, namely rangeland and wildlife habitat.

10.2 Impact on Fauna

The major effects on the fauna will be due to habitat disturbance and increased human activity. A total of approximately 2,027 acres will be affected. Complete modification of terrestrial habitats

10.2 Impact on Fauna

will occur during construction of roads and facilities, filling of reservoirs, and depositing of the raw and processed shale on the tract. Such modifications will render those sites unsuitable for wildlife until they are reclaimed and/or mitigating procedures apply.

The areas utilized most intensively by mule deer between October and April are off-tract in Piceance Creek valley and the contiguous south-facing slopes. Nevertheless, deer also ranged over the entire tract through much of the winter. Based on preliminary investigations of the tract region and vicinity it was concluded that winter deer numbers are generally greater in the immediate tract vicinity than in areas a few miles from the tract. Reduction of winter range by 2,027 acres in this area will significantly diminish the carrying capacity of the tract. The areas disturbed by construction of the surface facilities are located in one small area and in a large block of chained pinyon-juniper (Table 10.1 and Figure 10.1). The presence of the facilities, coupled with the constant presence of people, may cause deer to use other areas. Data suggest that approximately 40 deer that use the areas of the planned facilities may be displaced (26.7 deer-days/acre divided by 216 days or 0.123 deer/acre. If this value is multiplied by 500 estimated acres, the result is 6.2 deer per year affected).

TABLE 10.1

Estimates of Disturbed and Revegetated Acreage[1]

Disturbed Area[2]	Acreage Disturbed Before 1980	Acreage Disturbed During 1980	Acreage Revegetated Before 1980	Acreage Revegetated During 1980
ard House & Truck Scale Area	3.4			
wage Treatment Plant & Road		1.4		
) Topsoil Stockpile at site		0.3		0.3
liport & Public Relations Facility	0.6			
in Access Road	23.5			
cillary Area	17.2			
oposed Dame Site (East No Name)	1.2		1.2	
itchyard Area & Access Road		6.1		
plosive Storage Area	1.8			
ne Support Area	72.2			
w Shale Storage Area	6.0	5.0		
ck Stockpile Areas	7.7			
psoil Stockpiles (near Support Area)	5.5	3.0	5.5	3.0
ter Discharge & Application Area ond "C" Area)	3.7			
rigation System Pipelines[3]	4.0		4.0	
andoned Access Road	10.0		10.0	
	156.8	15.8	20.7	3.3

es revised from 1979 Annual Report based on aerial photos taken in 1980.

ated disturbed acreage in column corresponds to that shown on "C.B. Tract bed Areas Map", Figure 10.1-1.

e is an estimate-did not come from aerial photos.

acreage disturbed to date = 172.6

acreage revegetated to date = 24.0

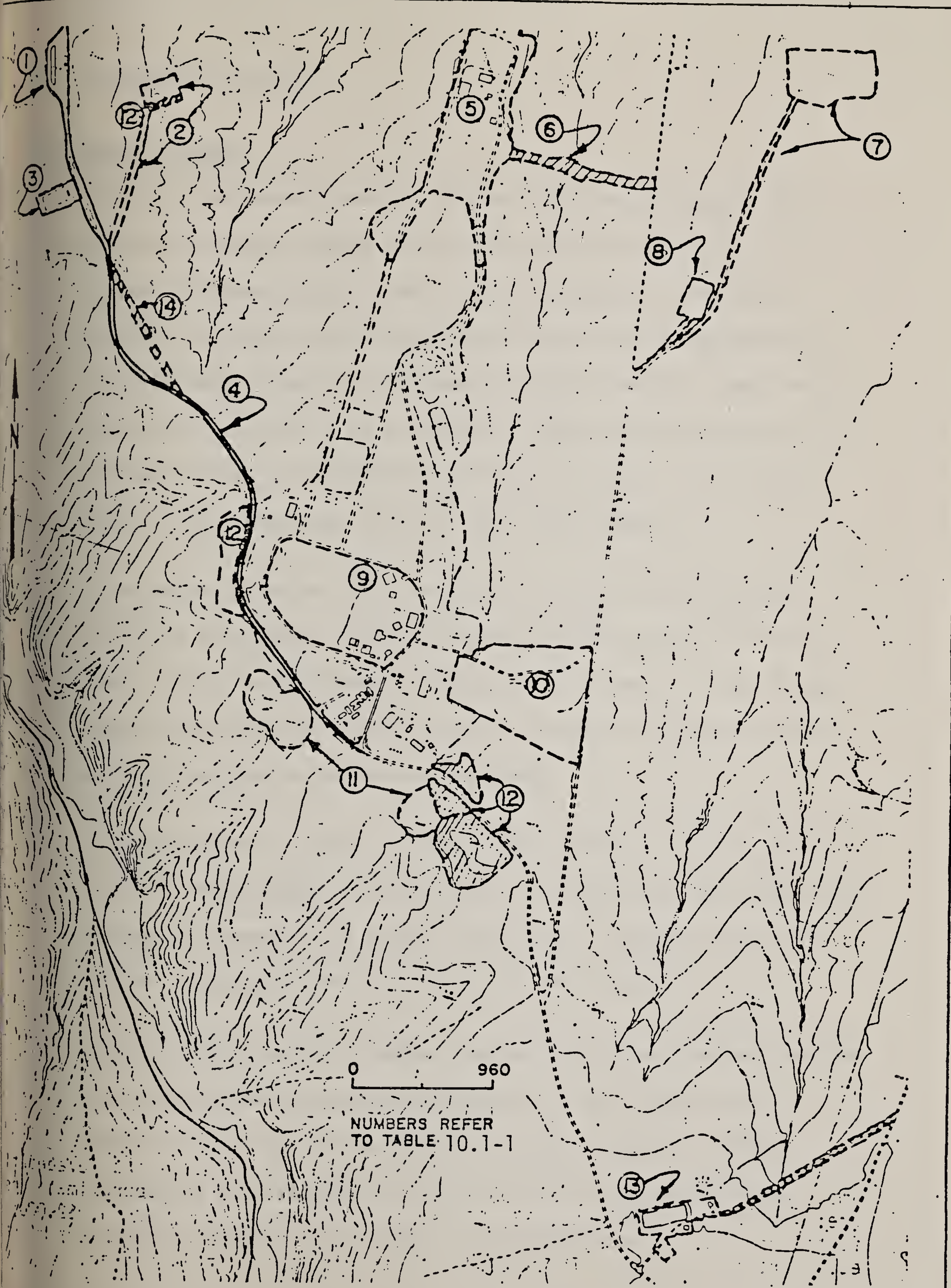


FIGURE 10.1 C-B TRACT DISTURBED AREAS MAP.

10.0 ENVIRONMENTAL EFFECTS

10.2 Impact on Fauna

Disposal of processed shale in Sorghum Gulch and Cottonwood Gulch will have the major impact on deer and wildlife in general. The fringes of pinyon-juniper along these drainages serve as travel corridors for deer moving to and from Piceance Creek during migration. Estimates made from the baseline data show that approximately 185 deer will be forced to a different ridge during migration (0.123 deer/acre multiplied by 1500 acres equals 185 deer). The disposal site is within the upper limit of deer winter range.

An estimated 235 animal unit months will be lost for livestock use during development. At the current grazing price, this represents a loss of approximately $555.00 to the Bureau of Land Management. Most of this loss will be during spring or fall grazing when the livestock are moving through the tract.

The construction of a dam in Willow Creek should not affect the mule deer to a large degree if construction is done during the summer when the deer are generally at higher elevations. The water quality in the dams is adequate for use by wildlife and livestock.

The main access road will impede some east-west deer movement through the pinyon-juniper type north of the tract. The impact may be through deer hit by vehicles while crossing the road. Indirect consequences of development of the tract are increased hunting pressure, poaching, trail biking, and snowmobiing.

10.0 ENVIRONMENTAL EFFECTS

10.2 Impact on Fauna

The effect of habitat loss on small mammals is drastic for the ones living in the proposed disturbed areas, but margional when considered from the standpoint of remaining similar habitat. Species in the avian population will be disturbed, and some will be replaced. If substantial changes in mammalian populations occur, changes may also occur in the abundance of certain raptor species. However, the small percentage of habitat to be disturbed relative to the total extent of similar habitats in the region suggests that local reductions in small mammal numbers should not have significant consequences on the habitat of wideranging raptorial species. The effects of air pollution on fauna are discussed in 10.3.4.

10.3 Air Pollution Effects, Visibility, and Noise

.1 Impacts on Air Quality

Ambient air quality impacts are discussed in Section 9.1, Volume I. Atmospheric pollutants will be produced by the operation of the C-b facilities. Pollutants expected to enter the atmosphere during the operation of the C-b facilities include sulfur dioxide, oxides of nitrogen, particulates, carbon monoxide, hydrocarbons, H_2S, aldehyde, ammonia, and trace quantities of fluoride and arsenic in particulate form.

The activities that will generate these substances include: modified in situ processing, aboveground retorting, mine ventilation, conveyor and transfer operations, stacking tower storage

10.3 Air Pollution Effects, Visibility, and Noise

.1 Impacts on Air Quality (Continued)

and bottom loadout, crushing and screening, bin (silo) loading, hauling, loadout, stockpile management, and vehicle and stationary engine operation.

Pollutant sources, emission rates and controls are discussed in detail in Section 9.1, Air Quality Control Plan. National Ambient Air Quality Standards, Colorado Ambient Standards, and State and Federal standards for the Prevention of Significant Deterioration (PSD) have all been established to minimize the degradation of air quality and effects of air pollution on health and welfare. The ambient air quality standards, incremental standards, and baseline concentrations are listed in Section 9.1. The Air Quality Control Plan, Section 9.1, was developed to ensure compliance with all State and Federal standards, and to prevent environmental effects from air pollution.

The estimates of expected concentrations that result from emissions from new sources must be calcualted using mathematical models. The modeled concentrations and concentration isopleths as discussed in Section 9.1 provide the estimates for comparison with established standards and are used for reference in literature reviews on the environmental effects of air pollutants. Table 10.2 is a summary of maximum expected off-tract concentrations.

TABLE 10.2 Maximum Expected Off-Tract Concentrations

Pollutant	Averaging Time	Concentrations ug/m^3	Concentrations ppm
Sulfur dioxide	24 hours	73	0.035*
	Annual	16	0.007**
Total Suspended Particulates	24 hours	27	
	Annual	7	
Nitrogen dioxide	Annual	63	0.04**
Particulate fluoride	24 hours	0.87	
	Annual	0.23	
Particulate aresenic	24 hours	0.014	
	Annual	0.004	

*Converted from ug/m^3 at 288°K and 789 mb
**Converted from ug/m^3 at 274°K and 782 mb

10.3 Air Pollution Effects, Visibility, and Noise

.2 Air Pollution Effects on Soils

Soils in the vicinity of the C-b Tract have been intensively sampled, analyzed physically and chemically, and described according to standard soil classification techniques. The characteristics of each of the soil types are discussed in detail in Section 3.2 of the C-b Final Environmental Baseline Report, and summarized in Table 3.2 of the document. Pertinent features of the soils in the area of maximum expected impact include an average cation exchange capacity (CEC) of 30.5 millequivalents (meq)/100 gm and moderate to high organic matter with an average of about three percent. In addition, the range of the soil pH is from 7.2 to 8.6 with all but two samples 8.0 or greater. The high pH is an expression of the calcareous nature of these soils that have generally high calcium concentrations of 4,380 ppm on the average. The average exchangeable sodium percentage is 2.1 with a range from 1.1 to 7.9 percent.

The EPA has published sensitivity criteria for soils with respect to acid precipitation (McFee, 1980). The nonsensitive category includes calcareous soils and soils with an average cation exchange capacity greater that 15.4 meq/100 gm. The calcareous soils of the tract vicinity have typical exchange capacities of about 30 meq/100 gm and an average calcium concentration greater than 4,000 ppm, placing them clearly in the nonsensitive class. No effects are expected in the maximum

10.0 ENVIRONMENTAL EFFECTS

10.3 Air Pollution Effects, Visibility, and Noise

.2 Air Pollution Effects on Soils (Continued)

expected air pollution concentration areas near the tract since the soils are insensitive. At further distances, concentrations decrease and no impact will be discernible. In general, acid deposition effects will not be discernible in simiarid western soils with buffering capacities of these magnitudes.

.3 Air Pollution Effects on Vegetation

Vegetation classification studies conducted in the vicinity of the C-b Tract have identified fourteen plant communities. Detailed descriptions of these communities are provided in Section 3.3 of the C-b Final Environmental Baseline Report.

The available literature on environmental effects of air pollutants on native vegetation and wildlife is very limited since most effects research has been done on agricultural crops, livestock, and ornamental plants as noted in the U.S. Fish and Wildlife Service publication entitiled Impacts of Coal-Fired Power Plants on Fish, Wildlife, and their Habitants (Dvorak et. al. 1978). Review of the National Park Service (NPS) Bibliography of Air Quality Effects on Natural Ecosystems (Howard et. al. unpublished) identified documents that are pertinent to the effects of low concentrations of air pollution on the semiarid econsystems of this region. These included the paper by Hill et. al. (1974) and the State of Montana Air Quality Standards

10.3 Air Pollution Effects, Visibility, and Noise

.3 Air Pollution Effects on Vegetation (Continued)

Environmental Impact Statement (1979). The EPA Air Quality Criteria for particulate Matter and Sulfur Oxides (in External Review Draft status) includes reference to these documents and summarizes the world literature on the effects of sulfur oxides and particulates on natural vegetation. Although these documents identify certain species as relatively sensitive, the effects of sulfur dioxide and particulates on species of this region are expressed only at concentrations much greater than those expected from C-b emissions.

Sulfur Dioxide. A compreshensive study on the sulfur dioxide susceptibility of many of the same species that are also present on or near the tract, was initiated by Hill and others (1974) in response to the lack of available literature on the effects of sulfur dioxide exposure at low concentrations. The investigators subjected the vegetation of many different plant communities to sulfur dioxide concentrations as low as 0.5 ppm. The study determined that nearly all of the 87 species fumigated were affected by short-term exposures of less than 2 ppm (see Table 10.3). A recent study by Thompson et. al. (1980) investigated the effects of sulfur dioxide and/or nitrogen dioxide on several species of native desert plants. Low concentrations of sulfur dioxide (0.22 ppm), nitrogen dioxide (0.11 ppm), or sulfur dioxide and nitrogen dioxide combined (0.11 ppm nitrogen

		DOCUMENTED THRESHOLDS		MAXIMUM ANTICIPATED	
DOUGLAS FIR	NO INJURY	0.5 PPM	5 HR	0.14 PPM	3 HR
NARROW-LEAF COTTONWOOD	2% INJURY	2	2 HR	0.14	3 HR
OREGON GRAPE	NO INJURY	10	2 HR	0.14	3 HR
SERVICEBERRY	0.2% INJURY	0.5	2 HR	0.14	3 HR
SNOWBERRY	0.3% INJURY	0.5	2 HR	0.14	3 HR
WILD ROSE	1% INJURY	2	2 HR	0.14	3 HR
ALFALFA	YIELD REDUCTION	0.06	68 DAYS	0.007	ANN.
PERENNIAL RYEGRASS	NO EFFECT	0.02	29 DAYS	0.007	ANN.
	INCREASED YIELD	0.03	10 WKS	"	"
	DECREASED YIELD	0.07	26 WKS	"	"
EVENING PRIMROSE	6% INJURY	1	2 HR	0.14	3 HR
GOOSEFOOT	2% INJURY	2	2 HR	0.14	3 HR
INDIAN RICEGRASS	0.2%	0.5	2 HR	0.14	3 HR
	"DELETERIOUS"	0.13	"LONG TERM"	0.007	ANN.
SCORPION WEED	NO INJURY	10	2 HR	0.14	3 HR
SCARLET GILIA	0.8% INJURY	2	2 HR	0.14	3 HR
TREMBLING ASPEN	2% INJURY	0.35	3 HR	0.14	3 HR

10.3 Air Pollution Effects, Visibility, and Noise

.3 Air Pollution Effects on Vegetation (Continued)

dioxide and 0.22 ppm sulfur dioxide), produced no significant difference between growth or dry weight of exposed plants and controls that were subjected to clean filtered air. The concentrations used were much greater than the maximum expected concentrations resulting from C-b emissions as previously shown in Table 10.2.

The State of Montana prepared an environmental impact statement during a study of the Montana air quality standards (Montana, 1979). The document summarized the available literature on sulfur dioxide effects at concentrations below 0.5 ppm. There were no studies reported that were not also summarized in the EPA Draft Criteria Document for Particulate Matter and Sulfur Oxides.

Lichens and bryophytes (mosses and liverworts) have been shown to be sensitive to sulfur dioxide. Studies of the sensitivity of lichens have shown that the foliose and furticose types are more sensitive to air pollution than crustose lichens. Lichens in the vicinity of the C-b Tract are predominantly the crustose types. In general, lichens of arid regions are relatively insensitive to air pollution (Marsh and Nash, 1979).

Nitrogen Dioxide. The concentrations of nitrogen dioxide required to produce acute injury in vegetation are much greater

10.3 Air Pollution Effects, Visibility, and Noise

.3 Air Pollution Effects on Vegetation (Continued)

than sulfur dioxide concentrations (Heck and Brandt, 1977). The pertinent study by Hill et. al. (1974) included fumigations of nitrogen dioxide from 0.1 to 5 ppm, along with the sulfur dioxide exposures. No evidence of synergistic effects at these ratios was detected. The research by Thompson et. al. (1980) determined no significant synergistic effects at low concentrations of sulfur dioxide and nitrogen dioxide combined. The maximum annual average nitrogen dioxide concentration expected from C-b emissions is only four percent of the lowest exposure level used in Thompson's study. The EPA Air Quality Criteria for Oxides of Nitrogen (External Review Draft 1978) provides threshold curves for the effects of nitrogen dioxide. Concentrations expected from C-b emissions as shown in Table 10.2 are far less that the threshold data discussed. The criteria document contains no reference to effects of the low concentrations on species present in the C-b vicinity.

Particulate Matter. Research on the effects of particulate matter on vegetation has been done on the emissions from cement kilns, soot, and coal dust (Montana 1979). Studies reported were typically on massive concentrations not experienced in rural areas. The available information on the effects of low concentration of particulate matter on the vegetation of semiarid climates is virtually nonexistent.

10.3 Air Pollution Effects, Visibility, and Noise

.3 Air Pollution Effects on Vegetation (Continued)

Other Pollutants. The impact of trace elements on vegetation is usually through gaseous absorption by leaves or uptake from soils by roots. No gaseous emissions of these substances are expected, and particulate forms will eventually be deposited on the soil surface for the most part. The calcareous, high pH soils of the region have large cation exchange capacities and soils with these characteristics can fix large quantities of trace elements and retain them in an unavailable form (Dvorak et. al., 1978). Heck and Brandt (1977) and the National Academy of Sciences (1971) reported McCune's (1969) technique of deriving injury threshold values for effects from atmospheric fluoride. Levels expected from C-b emissions as shown in Table 10.2 are below the threshold values discussed. The Montana (1979) study reported that particulate fluoride is less damaging than the gaseous fluoride for which the threshold values were derived.

Arsenic deposited to the soil surface tends to be retained in the surface layer or leached slowly, when in solution. Lime in soils may aid in maintaining the available arsenic below toxic levels, according to Dvorak and others (1978). Lime content of the soils in the C-b vicinity is generally high (greater than five percent) as discussed in 10.3.2.

Table 10.3 is a list of species that are present in the C-b vicinity and that have been shown to be sensitive to low

10.3 Air Pollution Effects, Visibility, and Noise

.3 Air Pollution Effects on Vegetation (Continued)

concentrations of sulfur dioxide, even though in each and every case, thresholds are much greater than the maximum concentrations expected from C-b emissions.

.4 Air Pollution Effects on Animals

Data on the effects of sulfur dioxide on animals have been generally derived from laboratory studies, clear-cut threshold levels for injury or death are not available (Dvorak et. al., 1978). Newman (1980) summarized the known effects on wildlife; no studies on the effects of low sulfur dioxide concentrations were reported. Effects of sulfur dioxide on vegetation are not expected, therefore, any secondary effect on wildlife thorugh forage consumption will not occur.

No research results on the effects of low nitrogen dioxide concentrations were reported in the summary document by Newman (1980) concerning the effects on wildlife. No effects on vegetation or wildlife are expected from nitrogen dioxide emissions from the C-b operations.

The effects of fluoride on mammals are primarily through ingestion of gaseous fluoride that accumulates in forage. Particulate fluoride is unable to penetrate leaf tissues, therefore, the amounts ingested would be neglible. Particulate fluoride

10.3 Air Pollution Effects, Visibility, and Noise

.4 Air Pollution Effects on Animals (Continued)

emitted is in a form that is poorly absorbed by animals (Coffins & Stokinger, 1977). Arsenic compounds do not accumulate in mammals (Dvorak et. al., 1978).

.5 Air Pollution Effects on Visibility

Fugitive dust and particulate matter sources as listed in 10.3.1 will produce visible particulates on and near the C-b Tract during operation. Control of particulate sources as discussed in Section 9.1 will minimize effects on visibility near the tract. Visibility impairment was estimated in the PSD permit application (incorporated by reference) under worst-case conditions by using the procedures derived by Latimer and Ireson (1980). Results of the analysis showed that there would be no impacts on visibility from pollutants emitted by commercial development at the C-b Tract.

.6 Noise Effects

Noise will be generated during the commercial development and operation of the C-b Tract. Activities that will produce significant above ground noise levels include: mine ventilation; hoist operation; material crushing, screening, stacking, and loadout; conveyor operations; raw and processed shale transport and stockpiling; aboveground retort operation; and vehicle and stationary engine operation.

10.3 Air Pollution Effects, Visibility, and Noise

.6 Noise Effects

Section 9.0 includes discussion of noise control and occupational noise impacts.

CB recognizes that data on the effects of noise on wildlife are minimal and highly controversial, however, CB is willing to attenuate noise levels associated with their operation to levels of approved background at a distance of one mile from the noise source. This will include the placement of noise associated activities in locations where the noise generated can be reflected or absorbed by natural barriers. Furthermore, CB will construct conveyor belts in a manner to provide shields for both dust and noise at transfer points to prevent abnormally high levels. Muffler systems of vehicles will be inspected to ensure their original specification regarding noise levels. Where applicable and practicable, CB will also schedule periodic noise-related activites for times that have minimal impact on wildlife.

10.4 Hydrology and Water Quality

.1 Lease Requirements and Stipulations

The Environmental Stipulations, (Section 1 & 9) attached to the C-b Lease, establish a number of requirements for monitoring both surface and subsurface waters on and near the tract. Objectives of these requirements are to establish baseline values for the quantity and quality of all water resources

10.4 Hydrology and Water Quality

.1 Lease Requirements and Stipulations (Continued)

associated with the tract, and to provide a means for monitoring any future changes in these resources resulting from the development of an oil shale industry.

With respect to surface water, the lease specifies that gauging stations are to be constructed on the major drainages of the leased lands and as defined by the Oil Shale Office, upstream and downstream from the leased lands. Data collected at these stations are to include continuous stream flow, water temperature, precipitation and sediment records, and periodic analyses for selected inorganic and organic chemical constituents. An inventory of natural features, such as springs and seeps, is required.

Groundwater requirements include: a test well at each mine site; an observation well in each water-bearing zone; analysis of water from the pumping test for organic and inorganic chemical constituents; record of water level and temperature in each observation well; after the initial test, collect water samples at six-month intervals; and one observation well upgradient from any proposed processed shale disposal site and at least two observation wells downgradient.

The above general lease requirements have been translated into a number of detailed conditions of approval by mutual agreement

10.4 Hydrology and Water Quality

.1 Lease Requirements and Stipulations (Continued)

between the Oil Shale Office, the Lessee, and various Federal and State regulatory agencies.

In addition to satisfying the specific environmental monitoring requirements, the hydrology program has been designed to obtain information needed to estimate the problems of water inflow to an access shaft and mine, to evaluate the need for importation of surface water, and to investigate methods of disposing of excess water.

Aquifer characteristics such as transmissivity, storage coefficient, potentiometric surface, water quality, and discharge and recharge rates are sought to aid in the development of a mining plan and to predict local effects that may develop from groundwater withdrawal.

.2 Hydrologic Conditions

Surface hydrologic conditions have been discussed in Chapter 2 of this volume and Volume II of the Final Baseline Report.

.3 Water Supply

A comprehensive water management program is being implemented at Cathedral Bluffs. Hydrology programs provide design criteria for mine development and monitor the effects from dewatering operations. Data will be used to predict local and regional

10.4 Hydrology and Water Quality

.3 Water Supply (Continued)

effects of groundwater withdrawal. Treatment will largely rely on conventional technology, including sedimentation, filtration, chlorination, reverse osmosis, flocculation, coagulation, and softening. The intention is to achieve optimal and economical use of all water to zero discharge.

Water availability and quality are major concerns of shale developers. In the Green River Formation oil shale region, the major water sources are the rivers of the Upper Colorado River Basin, supplemented by groundwater. Waste disposal and consumption in aboveground retorting production account for the largest part of the water requirement for oil shale production. MIS production requires relatively smaller quantities of water.

Surface retorting processes will require about three to four barrels of water for each barrel of shale oil produced; MIS processing will require only about two barrels of water for each barrel of oil produced. Less optimistic estimates place the water requirements for surface production at approximately twice this level. A report issued by the Colorado Energy Institute notes that the "projected water demand is well within the Colorado Compact allocation," even for a two million barrel per day shale oil industry. A U.S. Department of Interior environmental study, prepared in 1973, found that 341,000

10.4 Hydrology and Water Quality

.3 Water Supply (Continued)

acre-feet of water from the Upper Colorado Basin could be made available for oil shale development each year.

A comprehensive water plan for the oil shale industry in the White River Basin was commissioned by OOSI from Clifford H. Jex Engineers and Tipton and Kalmbach, Inc., Engineers in 1979. This plan proposed a cooperative effort by the oil shale industry to assure a steady annual industrial water supply to minimize the effect on existing water users, the local physical environment, and the water quality of the Colorado River Basin; and to be as compatible as possible with the other new uses, including recreation and the preservation of fish and wildlife.

During the early stages of retort start-up, through 1988, the on-site water supply is expected to exceed the demand. However, as more retorts come on line, the demand will probably increase more rapidly than the on-site supply, and an off-site supplement may be required. Depending on the season, the need supplement will vary from about 1,000 gpm in winter to about 5,500 gpm for the occasional summer maximum when cooling needs are exceptionally great.

Cathedral Bluffs holds an option for water rights on the White River that is strategically located and sufficiently senior in

10.4 Hydrology and Water Quality

.3 Water Supply (Continued)

priority to supply the Project's supplemental needs for feed-water, as well as its need to compensate for depletions, if any, from supplies of senior rights' holders that result from CB Project operation. Cathedral Bluffs has prepared a water augmentation plan to compensate for such depletions. Groundwater produced in dewatering the mine for which water rights have been secured by CB, will supply very early Project requirements. Further development of water supply plans are currently under way as a joint effort with other oil shale developers, the State of Colorado, and the Yellow Jacket Water Conservance District to investigate a unified supply plan for oil shale projects planned in the Piceance Basin. Cathedral Bluffs is participating actively in this joint effort. As a first step to catalyze a basinwide plan, CB commissioned preparation of "Plan for the Water Supply for Development of Oil Shale Industry in the White River Basin, Colorado" by Clifford Jex and Tipton and Kalmbach, Inc., in November 1979.

In summary, Cathedral Bluffs holds senior water rights and options on water rights to serve its need both for feed-water and to compensate for depletion to senior rights holders. Approximately five years will be needed to develop the first phase of the off-tract supply plan. The complete stand-alone plan must be in place sometime around 1988. A unified plan

10.4 Hydrology and Water Quality

.3 Water Supply (Continued)

should be ready in its first phases by 1990.

.4 Dewatering Effects

Analysis of extensive aquifer tests conducted on the tract has served to establish a working definition of the tract's geohydrology. These tests have established the presence of two major zones of low permeability and three major bedrock aquifers beneath the tract (Figure 10.2).

The information derived from the hydrologic testing program suggests that mine dewatering will not be a problem as originally anticipated. Because the rock was found to have smaller transmissivities and storage coefficients than predicted, less water will flow into the mine area than was initially projected. Moreover, it now appears that a limited stratigraphic interval adjacent to the mine zone can be successfully dewatered without appreciable disturbance of the overlying and underlying aquifers. This means that if shafts and wells are properly sealed, the dewatering operation will have little effect, if any, on springs and seeps in the vicinity of the tract.

Computer modeling to attempt to quantify the effects of shaft dewatering on the hydrologic regime is in progress. Preliminary results from this program indicate a peak inflow of only 3.7 cfs (1660 gpm) for the mine shaft and development mine. Additional

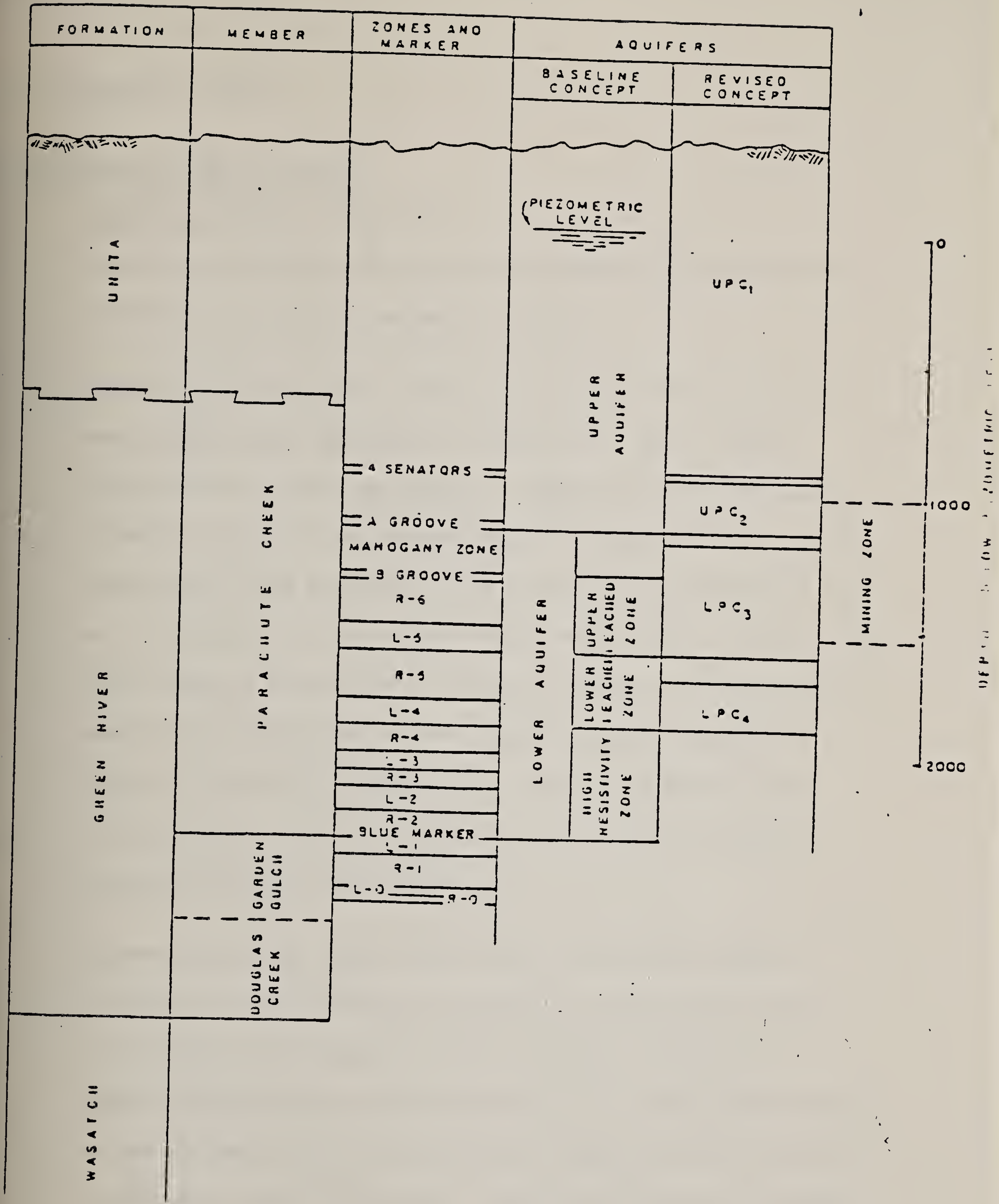


FIGURE 10.2
C-b Tract
STRATIGRAPHIC COLUMN AND AQUIFER CONCEPT

.4 Dewatering Effects (Continued)

modeling of the mine dewatering requirements will be undertaken as further information becomes available.

Dewatering during shaft sinking and related mining activities during 1980 caused declines in levels of the upper aquifer monitoring wells near the shafts. Contour plots of the potentiometric surface were made beginning in October, 1974. In the early years there were only a few wells with data available to us. The majority of these wells were within the C-b Tract. The plots showed a potentiometric surface sloping to the north and a gently axial high with a trend almost due north through the center of the tract (Figure 10.3). North of the tract the surface showed a north-northwest trend. This configuration persisted through June of 1979.

Beginning with the August 1979 plots, limited data became available to the northwest and north of Piceance Creek; from this time on, the contoured surface showed a strong northwesterly/southeasterly trend (Figure 10.4). The surface plunges to the northwest with the axis of the trough cutting across the northwestern part of the tract. The slight northward oriented bulge in the surface was still present. This configuration remained throughout the 1980 water year.

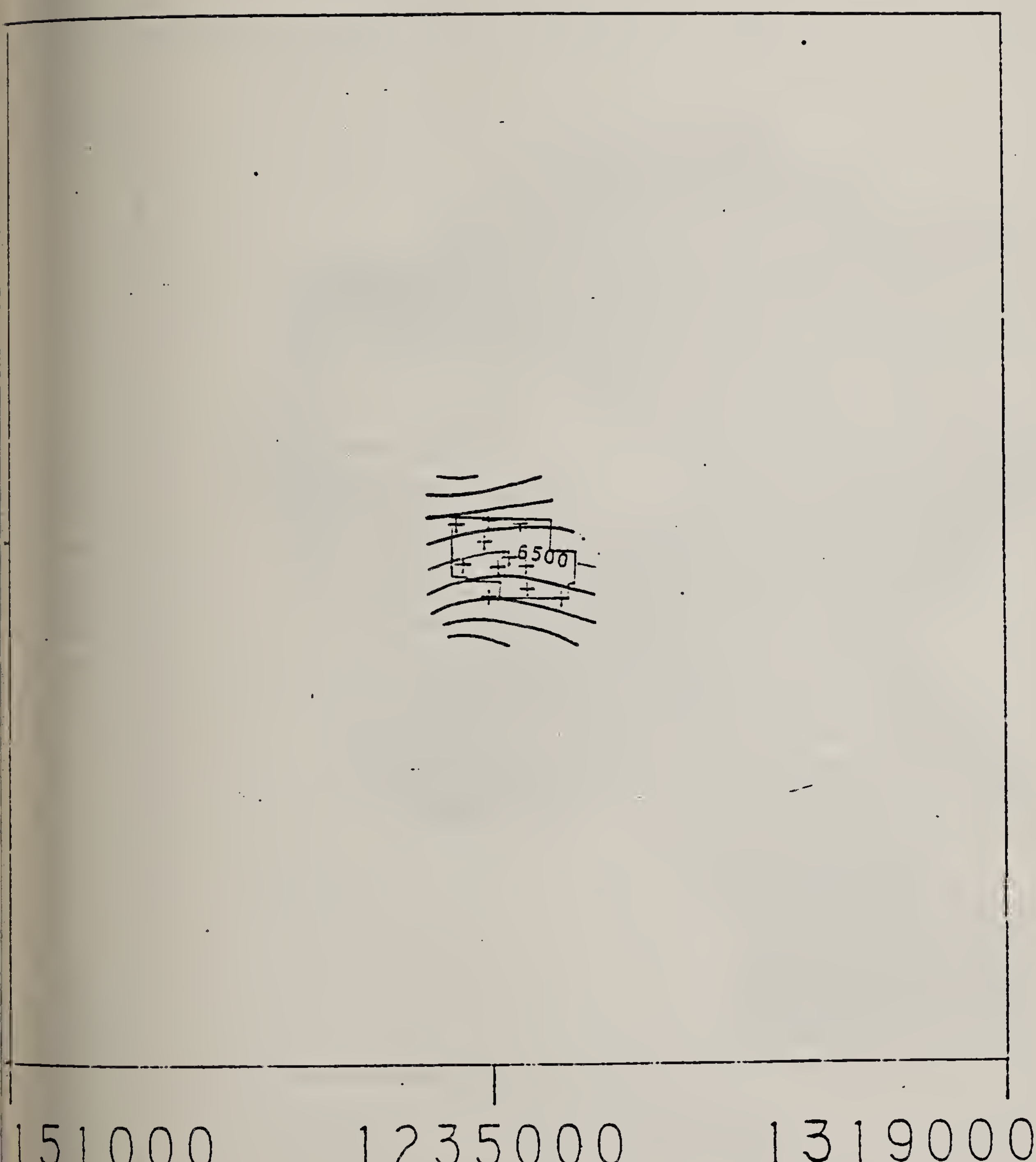


Figure 10.3

Potentiometric Surface for
Upper Aquifer Wells
June, 1979

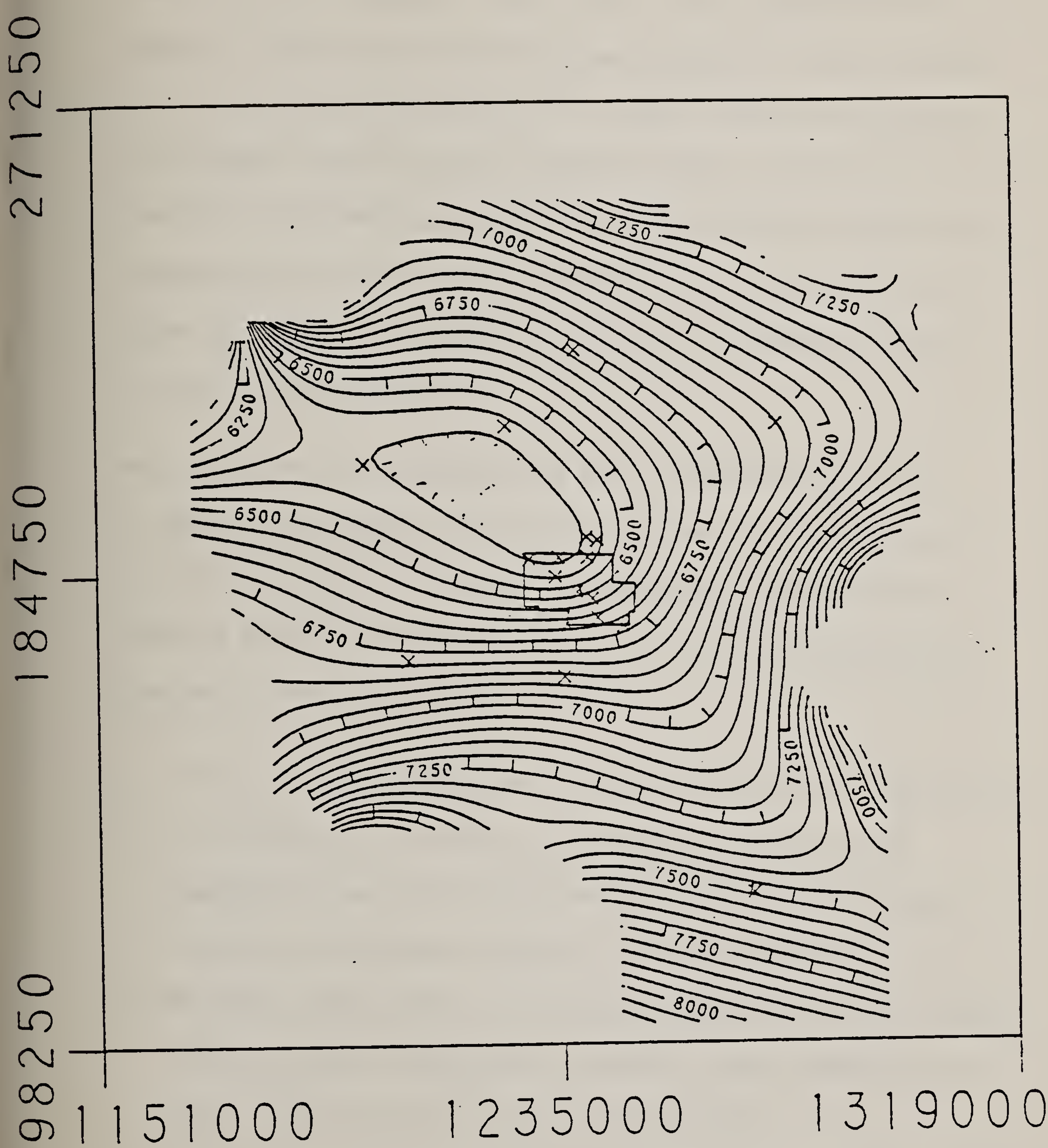


Figure 10.4

Potentiometric Surface for
Upper Aquifer Wells
September, 1980

10.4 Hydrology and Water Quality

.4 Dewatering Effects (Continued)

Two points are important here. The first is that the northwesterly trend of the surface became apparent in 1979, because for the first time data north of Piceance Creek were included. No data were available until October, 1979. The second point is that this northwest/southeast trend shows that the potentiometric contours did not wrap around Piceance Creek, but remained very close to the same direction of the cone of influence found in C-a Tract (See Volume II).

Most of the off-tract monitoring wells showed some decline in lower aquifer water levels, but the levels of decline are less than four feet. If these declines were related to dewatering activities on the tract, then the following would be observed in off-tract wells:

.1 The rate of decline should increase as the rate of dewatering is increased. If there is no increase in the rate of dewatering, the rate of decline would not increase unless the cone of influence reaches a hydrologic boundary.

.2 Declines should occur in decreasing amounts with the distance from the tract in any given direction. Local observations from a smooth inverse relationship may occur.

.3 There should be less decline in Lower Aquifer wells than in the Upper Aquifer wells.

10.4 Hydrology and Water Quality

.4 Dewatering Effects (Continued)

Plots of water level with time were made for all lower aquifer wells. None of the off-tract wells exhibited an increased rate of decline as dewatering progressed. A time lag might be expected at remote distances from the drawdown site; however, the response is usually quite rapid in confined aquifer systems.

The declines in the lower aquifer wells do not occur in decreasing amounts with distance from the tract; for example, the decline at WY68 is two and one-half feet. Eight miles north, the decline in WY64 was four feet. No decline occurred in a composite well 2.5 miles northwest of the tract, and yet a well 2.5 miles further northwest had two feet of decline. The examples cited here are evidence that declines in the levels in the lower aquifer wells off-tract are not related to activities on the C-b Tract.

.5 Water Quality

A development monitoring program has been implemented to provide water quantity and quality data to help determine if changes in flows or parameters exist, and if changes are detected, to determine whether the changes are natural or caused by development of the C-b Tract. Streams, springs, seeps, and wells in the alluvium, upper and lower aquifers have been monitored since baseline. The program was expanded in 1979 to

10.4 Hydrology and Water Quality

.5 Water Quality (Continued)

accommodate monitoring required by the "Water Augmentation Plan" and Court Decree (W3492) which includes monitoring of water pumped from shafts and the mine as it is developed, and additional monitoring of springs, wells, and precipitation stations. The generalized and simplified two-layer aquifer system concept guided the measurements of flows, levels, and water quality parameters. Figure 10.2 shows the generalized concept along with the more detailed set of aquifer units and the interval planned for retorting at Tract C-b.

In the baseline program, all parameters measured were selected without previous knowledge of their importance. For example, water quality monitoring was instituted on ephemeral streams without knowledge of the flows. In addition, the baseline program revealed certain deficiencies in earlier concepts of the tract hydrology. The baseline program confirmed the complexity in hydrology and geology that was previously suspected.

The earlier generalized description of two aquifers separated by the Mahogany Zone is now outdated as supporting data show. A simplification of the more complex system is shown in Figure 10.2, including strata that have been tentatively considered, at least locally, to be aquitards. For purpose of identification, the new subdivisions are:

10.4 Hydrology and Water Quality

.5 Water Quality (Continued)

UPC_1 - Upper Parachute Creek #1: Approximate limits extend from the Uinta Formation to the top of the 4 Senators Zone

UPC_2 - Upper Parachute Creek #2: Extends from the base of the 4 Senators Zone to the base of the A-Groove.

LPC_3 - Lower Parachute Creek #3: Extends from 30 feet below the base of the A-Groove to the top of the R-5 Zone.

LPC_4 - Lower Parachute Creek #4: Extends from the middle of the R-5 Zone to the base of the L-4 Zone.

The interval encompassed by the UPC_2 and LPC_3 subdivisions of the aquifer system conforms to the zone presently planned for retorting. This zone will be dewatered during mining operations. Several bedrock wells were recompleted according to the more complex aquifer systems. Under the previous development plans for C-b, the hydrologic monitoring program was revised to cover the changing phases of development. The first phase covered the period from the completion of the interim monitoring period to the completion of shafts. The second phase covers the period of lateral drifting and mine dewatering to retort ignition and commercial mine construction and operation.

During the early stages of mine development, surface water and groundwater quality may be affected by the release of excess mine water by discharge to Piceance Creek via East No Name

.5 Water Quality (Continued)

Gulch, reinjection to deep underground aquifers, land application by means of a sprinkler system or some combination of these techniques. Monitoring of the quality of these waters is discussed in detail in Volume II.

Mine water is currently discharged to the surface under a temporary NPDES permit; requested amendments to a proposed new NPDES permit are being considered by the Colorado Water Quality Control Division. Discharging continues during this administrative review. Although discharging is currently an important water management tool, it will not be essential to long-range water management. After full commercial operation is achieved, all mine water will be treated or recycled for use in the surface processing facilities. The CB Project is committed to zero discharge after commercial operations are fully established. Reinjection and land application by sprinkler irrigation are techniques under investigation to provide flexibility in water management. The results of these investigations are discussed in detail in Chapter 5, Volume II. According to a USGS study, the chemical quality of ground water in the Piceance Creek basin varies both within and among the aquifers. Details are provided in Chapter 5, Volume II. In general, the lower aquifer is more saline than the upper aquifer. Within each major aquifer, the concentration of TDS fluctuates over a range of several hundred

10.4 Hydrology and Water Quality

.5 Water Quality (Continued)

milligrams per liter (1980 CB Annual Report). Water from the upper aquifer is generally a mixed soldium-sulfate/sodium-bicarbonate type. Water from the lower aquifer is generally a mixed sodium-bicarbonate type. This water is used to a limited extent for stock watering and is not used for drinking water supply.

A major water quality concern centers on the extent to which mobile salts might leach out of the processed shale disposal areas from aboveground retorting into groundwater supplies. Shale disposal will be handled by techniques that prevent groundwater from contacting the processed shale (Section 9.2, Volume I). Backfilling of underground mines with a portion of the processed shlae may be acceptable if the permeability of the backfill is low enough to prevent significant salt release.

MIS processing poses a substantially smaller threat to groundwater quality because retorting temperatures are higher and time for retorting is longer. Extensive laboratory tests by Occidental Research Corporation (ORC) and the U.S. Bureau of Mines have determined the kinetics of mineralogical change during retorting. Oil shale pellets were analyzed after retorting for a given length of time at a given temperature. Results were verified by comparison with data on actual cores from MIS

10.0 ENVIRONMENTAL EFFECTS

10.4 Hydrology and Water Quality

.5 Water Quality (Continued)

processed shale obtained from Occidental retorts in the field. These studies clearly show that the carbonates present in shale are converted to insoluble silicates when the shale is subjected to temperatures in excess of 1300°F over long periods of time. If it leaches, the processed shale produces a leachate whose ion concentrations are comparable to that of the groundwater in Colorado River Basin, as shown below:

	Colorado River Basin Groundwater (mg/l)		Leachate of Pellets Retorted at (mg/l)	
	Upper Aquifer	Lower Aquifer	1260°F	1600-2160°F
K+	1.5	11	35	5
Na++	210	3980	121	10
Ca++	50	7.4	109	11
Mg++	60	9.5	2.4	2.6
Si+4			20	10
SO_4	320	80	465	70

Storage of raw shale feed stock above ground will be done using techniques to prevent potentially leachable salts from entering surface waters or groundwater. These techniques are discussed Section 9.2, Volume I.

10.5 Objects of Historic or Scientific Interest and Aesthetic Values

The proposed development will result in surface modifications which could potentially destroy objects of historic or scientific interest. Likewise, development activities will affect certain of the scenic

10.0 ENVIRONMENTAL EFFECTS

10.5 Objects of Historic or Scientific Interest and Aesthetic Values

values and aesthetics of the area. As an initial part of the Lessee's plans to protect these assets, archaeological and scenic values studies have been undertaken on the tract and surrounding area (Chapter 9.0, Volume I). Additional efforts by the Lessee to comply with the Lease terms and other applicable regulations are described below:

.1 Objects of Historic or Scientific Interest

Proposed Activity Affecting Objects of Interest. Past and future activities by the Lessee will result in the modification of approximately 2,027 acres by the completion of the project, of which 1,000 to 1,200 acres will be the processed shale pile. Proper precautions will be taken in advance of and during these developments to avoid damage to objects of scientific or historic interest that have been identified to date.

Lease Requirements and Compliance Plan. Section 6 of the Lease Environmental Stipulations requires that Lessee not harm any object of antiquity or of historic or scientific interest. As part of the first year of baseline data-gathering programs, tract-wide archaeological studies were undertaken by the Lessee. To date, all earth disturbances on the tract have been preceded by a survey and investigation by professional archaeologists. The Oil Shale Office has copies of all information. The limited finds discovered at various sites during the studies have been

10.0 ENVIRONMENTAL EFFECTS

10.5 Objects of Historic or Scientific Interest and Aesthetic Values

.1 Objects of Historic or Scientific Interest (Continued)

marked and catalogued for preservation and future reference. Sites will be considered during planning. Virtually all sites lie outside planned disturbance areas.

The OSEAP has recommended guidelines for protection of historic and scientific sites of interest. It is the intent of the Lessee to follow these guidelines and conscientiously investigate, record, and protect any sites or materials deemed important or vital by professional investigators. The following procedures will be taken to assure that items of historic and scientific interest will be preserved:

- Qualified professionals will be used to evaluate, salvage and guide programs for historical, archaeological and scientific site protection prior to site disturbance.
- Qualified professional personnel will evaluate finds during earth moving operations. If earth moving reveals an object on the site, work will be halted until experts can evaluate the find.
- Notice of any discovery will immediately be given to the OSO.
- All employees will be briefed on the nature of scientific resources that might be located on-tract based on past surveys.

.2 Aesthetic Values

Proposed Activity Affecting Aesthetic Values. As part of an overall plan to preserve the aesthetics of the area, a scenic

10.5 Objects of Historic or Scientific Interest and Aesthetic Values

.2 Aesthetic Values (Continued)

value study of the tract and vicinity was undertaken by the Lessee. The objectives of this investigation were to inventory the type of quality of presently existing scenic resources, to determine the visual sensitivity levels (classes) of various parts of the tract and surrounding area, and to establish criteria for judging the effects of development on scenic values. A summary of the study is in Section 9.6, Volume I.

Results of this study show that few of the activities will be visible from most general public viewing locations of the area. Local traffic on Piceance Creek Road will see little of the construction activities since most of the tract is not visible from the road. The plant structures and processed shale disposal areas will not be visible in most general public views of the area. Abandonment activities will result in general scenic values being restored to approximately their original condition.

Lease Requirements and Compliance Plan. Section 12 of the Lease Environmental Stipulations requires Lessee to follow certain standards for the protection of scenic values and consider aesthetics in planning, construction, reclamation and mining operations. In general, the Lessee intends to incorporate

10.5 Objects of Historic or Scientific Interest and Aesthetic Values

.2 Aesthetic Values (Continued)

the visual management guidelines developed by the U.S. Forest Service for retaining the scenic quality of the tract and environment (Section 9.7, Volume I). The procedures set forth in Section 12 of the Stipulations also will be followed to minimize the impact on aesthetic scenic values resulting from development activiity. Specific procedures the Lessee intends to use in designing, clearing, earthmoving, and construction are described below:

- Large volumes of material will be placed so that the longitudinal axes are parallel to the existing ridge and creek patterns. Outlines will be shaped similar to the ridges of the sourrounding area. Gentle undulations matching local draws and gullies will be copied insofar as possible. Straight lines of cuts and fills as well as other surfaces will be contoured and broken as much as possible so as to form loose, informal and natural-looking slopes. Irregularities of slope will be concentrated near the base of fills and tops of cuts with areas toward roadway remaining geometrically more formal. This provides a gradual change from straight to natural lines and surfaces. Existing terrain features such as ridges, draws, gullies, etc., will be used as a guide to shape, mold, fill and cut slopes.
- Surface materials have a great influence on revegetation

10.5 Objects of Historic or Scientific Interest and Aesthetic Values

.1 Aesthetic Values (Continued)

efforts and topsoil or seed bed requirements must take precedence over other considerations. However, where coarse material must be used to protect surfaces from rapid runoff, slopes will be built to resemble natural banding. If possible, surrounding natural irregularities will be repeated and matched, and embankment slopes blended into the surrounding natural terrain.

- New vegetation will be blended in by the proper combination of revegetation and geometric placement. Vegetative cover will be selected that is similar to surrounding native types.
- Features will be designed to blend into a composite landscape design that is not only aesthetically pleasing, but preferable from an operations and maintenance viewpoint. Properly constructed and revegetated, even cuts as well as embankment slopes will become a part of the landscape.
- Slope rounding, which eliminates pronounced and artificial-looking edges of the cut and fill, will be done wherever possible. Sharp edges and uniform large surfaces will be avoided. Whenever possible, long uniform slope areas will be slightly undulated and warped to form slide draws and small ridges as illustrated in Figures 10.5 and 10.6.
- For aesthetic reasons and also to minimize erosion damage, efforts will be made to conserve existing vegetation near or along the edge of the Project facilities.

10.5 Objects of Historic or Scientific Interest and Aesthetic Values

.2 Aesthetic Values (Continued)

- Particularly in valley bottoms or along natural runs, slope rounding can be modified, and with some special placement of larger rocks, islands of trees or shrubs may be preserved.
- All structures will be colored, painted and textured to blend readily into their surroundings.

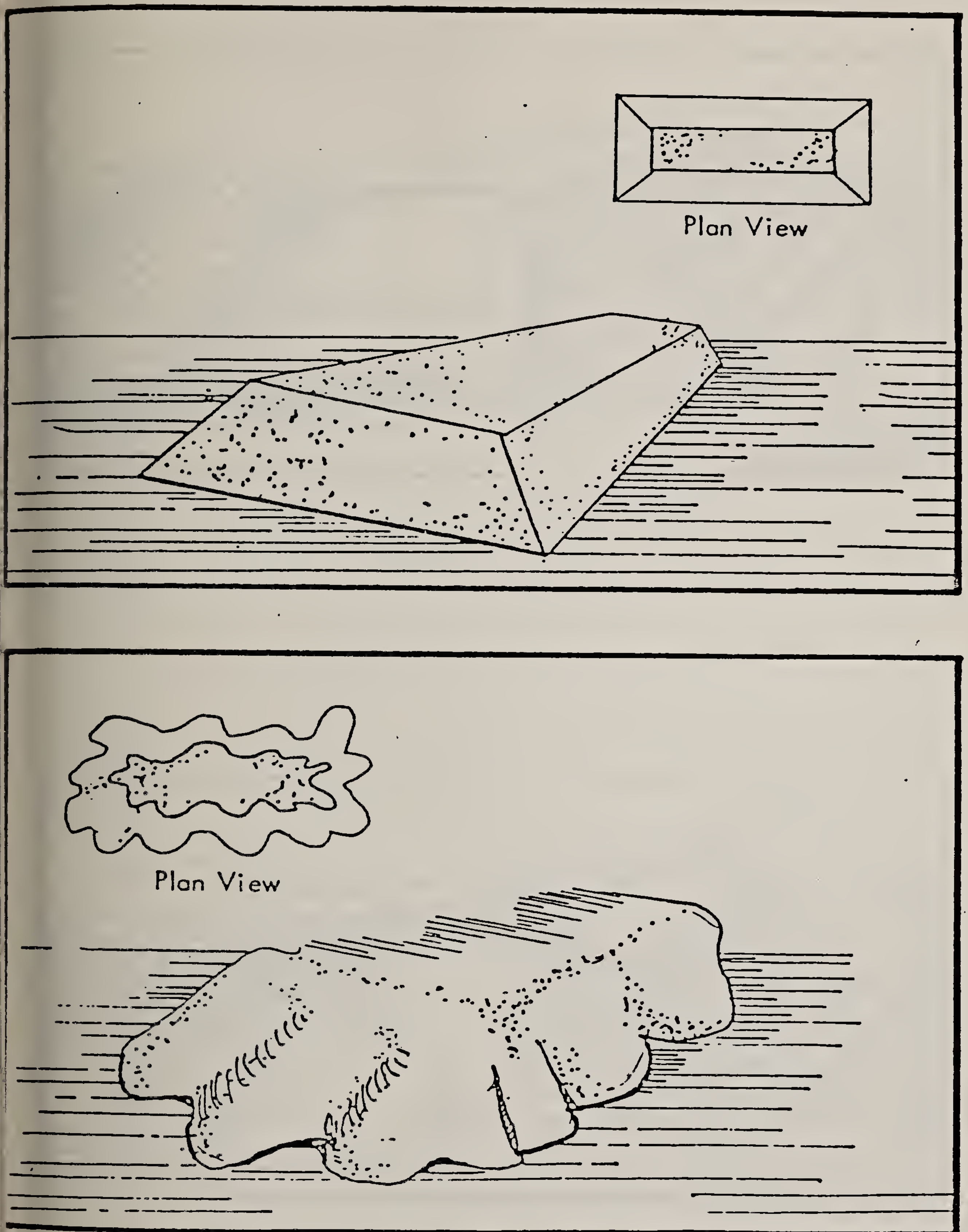


Figure 10.5 VARIATION OF SLOPE ROUNDING

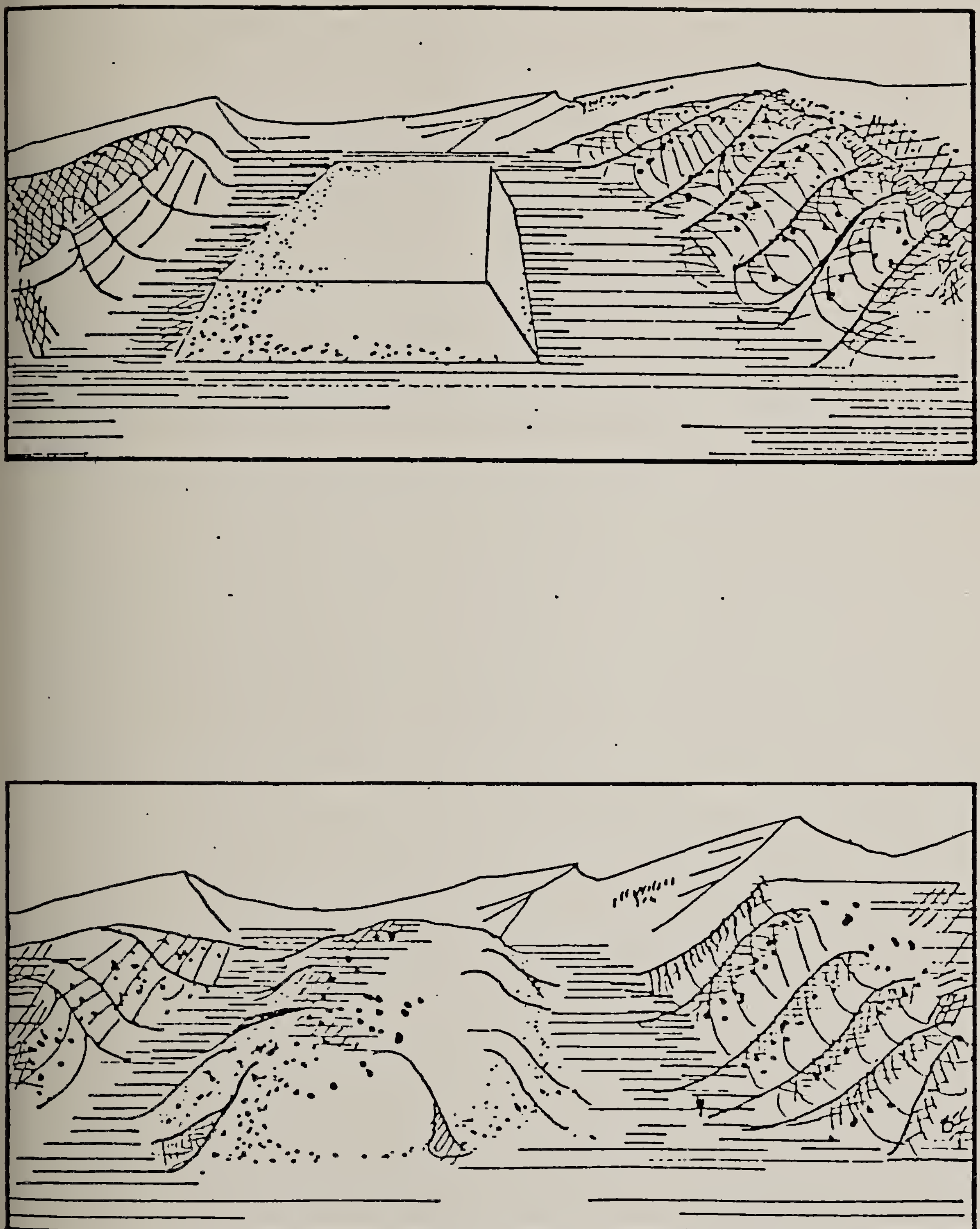


Figure 10.6 VARIATION OF SLOPE ROUNDING
(continued)

11.0 ALTERNATIVES

11.1 Introduction

Cathedral Bluffs is currently studying alternative mining, retorting, and waste disposal schemes in an effort to achieve the goals set forth in the Prototype Oil Shale Leasing Program, of which Tract C-b is a part. These goals include:

- Ensuring the environmental integrity of the affected areas;
- Utilizing different oil shale extraction and retorting methods wherever possible;
- Permitting an equitable return to all parties in the development of this public resource; and
- Providing the Nation with a new source of energy in a timely fashion.

Alternate mine designs that could accelerate the commercial production of shale oil and on-site upgrading facilities are among the many options being considered by CB. Further, several surface retorting technologies are being examined to determine the process most compatible with oil shale underlying the tract. Studies will be conducted throughout the life of the project to maximize resource recovery and make Tract C-b as self-sufficient as economically practical.

11.2 Underground Disposal of Processed Shale

Hydraulic backfilling of mine openings with processed shale is being studied as an alternative waste disposal method. Some principal advantages and disadvanatages of hydraulic backfill, as utilized at Tract C-b, are listed below.

11.0 ALTERNATIVES

11.2 Underground Disposal of Processed Shale

Advantages:

- Reduced amount of retorted shale disposed of on the surface; and
- Possible improved ground control with reduced surface subsidence.

Disadvantages:

- Large quantities of water must be diverted from an already limited supply; and
- An extensive surface plant and placement network must be constructed.

Hydraulic emplacement of mill tailings has been in use at a limited number of North American metal mines since as early as 1928. However, the feasibility of backfilling MIS retorts with processed shale remains unproven. The possibility of underground disposal was mentioned in the 1973 E.I.S. for the Prototype Oil Shale Leasing Program, although the technical aspects of such a disposal system were not addressed.

The Denver Research Institue published a report on disposing processed shale ash in in-situ retorts. Current studies are also underway at the USBM Spokane Research Center, the Colorado School of Mines Research Institute, Solinc, Inc., and the Lawrence Berkeley Laboratory. These studies have gathered a large amount of data on the physical and mechanical properties of several different oil shale grout mixes, although little emphasis has been placed on actual production and placement of such grout.

11.0 ALTERNATIVES

11.2 Underground Disposal of Processed Shale

A surface preparation plant, depicted in Figure 11.1, would be required to produce hydraulic fill. The parameters incorporated in the design of this flow chart are:

- Void space filled by grout equals 20 percent of volume of MIS retort.
- Nearly 541,400 Ft^3 of grout can be backfilled per day during Phase I (540,300 Ft^3/ day during Phase II).
- Surface retorting will produce 48,566 TPSD processed shale at a density of 80 PCF, therefore approximately 45 percent of the shale can be consumed by backfilling.
- Fill material will contain no more than 8 percent passing 0.014 mm. Size distribution data is for Lurgi material.
- Grout mix has water to solids weight ratio of 0.7 to 1.
- Retarder or fluidizer must be used to keep backfill mix from prematurely setting up.

Hydraulic backfilling of retorted shale is certainly a convenient means of disposal from an environmental standpoint. Unfortunately, the great amount of water necessary to conduct such an operation is also a great environmental concern. The USBM and LBL have indicated that a water to solids weight ratio of 0.7:1 is necessary to prepare a suitable grout mix. Backfilling at a maximum capacity for the life of the project would consume 45 percent of the surface retorted shale. This amount of fill would require approximately 4,000 acre-feet of water per year. According to USBM, little or no water would be recovered after grout is injected into the retort. In addition,

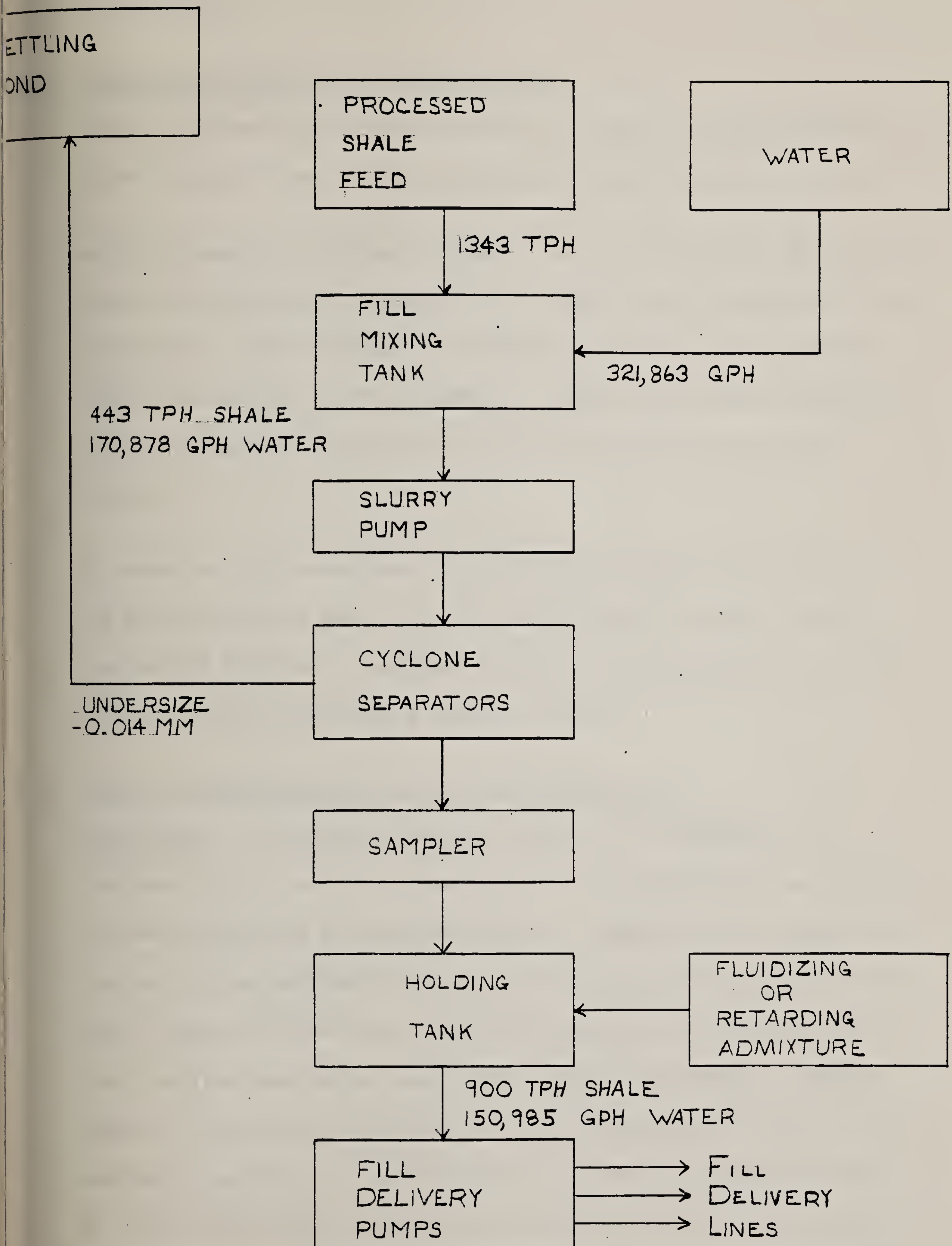


FIG. 11.1

HYDRAULIC FILL PREPARATION

11.0 ALTERNATIVES

11.2 Underground Disposal of Processed Shale

studies indicate that the MIS retorts will have to be pre-saturated prior to backfilling, further taxing the water supply.

Another drawback to hydraulic backfilling is that current theories for injection methods and permeability of spent retorts are no more than conjecture. Injecting backfill into the void spaces inside burned retorts would require the placement of distribution pipes throughout the rubble sections to fill even 20 percent of the total retort volume.

In summation, the advantages of underground disposal of 45 percent of the processed shale generated at Tract C-b must be weighed against the loss of 4,000 acre-feet/year of water from the Piceance Basin and the high cost of providing a backfill system.

11.3 Materials and Consumable Supply and Distribution

Explosives. The anhydrous ammonia that will be recovered as a byproduct in the surface process facilities is the basic raw material for the manufacture of ammonium nitrate. Ammonium nitrate makes up the bulk of the ANFO and slurry explosives that will be used in the mine. Because of the large daily requirements for such explosives, their on-site manufacture would offer certain advantages. Whether these will outweigh the capital and operating costs of the necessary manufacturing plant is currently being studied by Cathedral Bluffs. An onsite plant would eliminate the otherwise planned truck haulage of both explosives and ammonia over 40 miles of narrow and winding

11.3 Materials and Consumable Supply and Distribution

highway between the site and the railhead at Rifle, Colorado. In addition to the savings in transportation costs, traffic congestion on the overtaxed secondary highway system would be reduced.

Only part of the recovered anhydrous ammonia would be consumed in meeting the mine explosive requirements. The remainder could be marketed as fertilizer as now planned, or be used on-site to stimulate revegetation. Also, it could be converted to ammonium nitrate for the anticipated future explosive needs of other oil shale mines in the general area. Ammonium nitrate is a fertilizer that may command a higher market price than the liquid ammonia because of its higher nitrogen content and its easier application to the soil as a granular solid. If used as a fertilizer, it need not be converted to the prill form required in ANFO explosives.

The ANFO explosive for mine use is formulated by mixing the dry ammonium nitrate prills with No. 2 diesel fuel oil or its equivalent in other suitable carbonaceous material. 15 BPD of such fuel oil will be required for the 40 TPD of ANFO used in the mine. It is possible that an equivalent amount of the lighter shale oil fractions entrained in the retort offgas stream could be used for such purpose. Actual testing will be necessary to determine its suitability. Unrefined shale oil should be less costly than diesel fuel oil, and it need not be transported to the site.

11.0 ALTERNATIVES

11.3 Materials and Consumable Supply and Distribution

Diesel Fuel. The large quantities of diesel fuel oil that will be required daily by the mobile equipment in both underground and surface opertions would suggest an alternate delivery to the site by pipeline rather than by tanker truck transport as now planned. The small (4-6 inch) pipeline currently under consideration for initial product shipment from the site might be used for diesel fuel delivery after a common carrier product pipeline becomes available (See Section 8.5). Delivery in tank cars over a railroad spur also may be a feasible alternative.

Concrete and Shotcrete. An average of some 200 cubic yards of concrete and shotcrete will be used daily in the mine. This will involve 70 TPD of Portland cement and 350 tons of fine and coarse aggregate. Cement will be delivered to the site in bulk transport trucks either from its point of manufacture in Colorado or Utah or from the railhead at Rifle. Aggregate also will be hauled to the site by truck, most likely from sand and gravel pits in the Colorado River Valley either down or upstream from Rifle. Providing a railroad spur to the site would eliminate the truck haulage of all such bulk materials over the highway system.

Limestone. Flue gas from the retort offgas-fired steam boilers must be desulfurized before discharge to the atmosphere. Some 518 TPD of high purity limestone (finely ground in a low solids/water slurry) will be used for this purpose. The nearest source of such material

11.3 Materials and Consumable Supply and Distribution

is the small inactive quaries in the Leadville limestone formation on the outskirts of Glenwood Springs, Colorado. Glenwood Springs is 26 miles via Interstate Highway 70 east of Rifle. Present plans call for trucking mine-run limestone to the site for fine grinding and slurry formation before use in the desulfurization process. However, because of the quantity of raw material involved, its delivery by pipeline in final slurry form may be a viable option. Here again, delivery of the bulk material over a railroad spur would be another possible option.

Nahcolite, a natural sodium bicarbonate occurring with the deeper oil shales in the central part of the Piceance Creek Basin, also is a potential absorbant of sulfur dioxide in power plant stack gases. Some 29 billion tons of such material is present in the basin. The 30 million tons of moderate to low grade nahcolite material on the tract is not considered minable within the foreseeable future inasmuch as it is located in the L-3 zone with lean oil shale (less than 20 gallons per ton), 700 feet below the planned MIS retorting horizon. However, other proposed mining operations within the basin have indicated an intent to recover nahcolite either as a primary product or as a co-product with oil shale and its other associated minerals. Should an assured supply become available in the future, this material would be evaluated as a possible alternative to the now planned use of limestone for sulfur dioxide removal.

11.0 ALTERNATIVES

11.4 Alternate Fuels

The large volumes of low and high-BTU offgases exhausted from the underground and surface retorts will serve as fuel for the gas-fired boilers in the modular steam plant. Steam from this plant will be used for a variety of process applications as well as for other purposes, including the generation of virtually all onsite electric power requirements. Natural gas or coal, both available in the general area, could be used as an alternate fuel for a boiler plant to produce the necessary process steam. Electric power also could be generated by the steam produced with alternate fuels; or it could be purchased offsite from a local electric association, subject to its existing supply capability.

Although alternate fuels could be substituted for most energy requirements, none would be as cost effective as a suitable byproduct fuel readily available onsite. Retort offgases will be produced regardless of how the onsite energy requirements are met; and if not used, must be wasted to the atmosphere under rigid environmental constraints. The use of alternate fuels in lieu of the readily available offgas would significantly affect the energy efficiency of the project and would not be compatable with energy conservation.

Large quantities of diesel fuel oil will be required for the operation of the mobile mine and surface equipment. Diesel-powered mobile equipment is more or less standard for surface operations and, in most cases, is the only type available. Electric power is being studied as an alternative to diesel power for mobile mine equipment, since power generated on-site may be available to operate such equipment.

11.0 ALTERNATIVES

11.5 Alternate Retorting Methods

.1 C-b Tract Options

Mined shale from C-b Tract in-situ retort operations will be surface retorted to increase the overall tract oil yields. Surface retorting also allows oil production to continue if in-situ operations are interrupted for any reason. The surface retorting method currently being considered is the Lurgi-Ruhrgas process. However, other surface retorting schemes remain viable alternate candidates including the Union B, Paraho direct heat, and circular grate (Superior and Dravo) direct heat processes. Process descriptions for these alternates are based on licensor information. Process differences are summarized for reference only in Table 11.1.

Table 11.1 Summary of Alternate Retorting Methods

Process	Description	Oil Yield (% FA)	Feed Size (Inches)	Heating Value	Discharge State	Carbon Recovery
Lurgi-Ruhrgas	Solids Transer Indirect Heat	100+	-1/4	High	Dry	Yes
Union B	Gas Transfer	100	1/8 to 2	High	Wet	No
Paraho	Direct Heat	93	3/8 to 3-1/2	Low	Dry	Yes
Dravo	Direct Heat	99	1/4 to 2	Low	Dry	Partial
Superior	Direct Heat	98+	1/4 to 4	Low	Dry	Partial
Tosco II	Solids Transfer Indirect Heat	100+	-1/2	High	Wetted	No

.2 Union B

Union Oil Company has developed three processes using a proprietory rock pump feed mechanism. Raw oil shale sized 1/8 to 2 inches is injected upward into a vertical kiln. The three

11.0 ALTERNATIVES

11.5 Alternate Retorting Methods

.2 Union B (Continued)

processes include the direct heat Retort A, the indirect heat gas transfer Retort B, and the indirect heat gas transfer steam gas recirculation SGR-3. Only Retort B will be considered here.

Retort B utilizes recycle gas which is heated indirectly in a furnace to about 950-1000°F. Both fixed-bed and continuous pilot plant operations gave high yields of liquid product, essentially equal to Fischer Assay values. The treated make gas has a high heating value, about 800 BTU/ft^3. The process produces excellent quality products. The discarded retorted shale contains a nominal carbonaceous deposit depending on original aromatic carbon content.

The retort is depicted in Figure 11.2. Oil shale from the feed bin flows through two feed chutes to the solids pump. Shale oil product acts as a hydraulic seal in the feed chutes to maintain the retort pressure.

The solids pump, mounted on a movable carriage, is completely enclosed within the feeder housing and immersed in shale oil. The pump consists of two piston and cylinder assemblies which alternately feed shale to the retort. While one cylinder is filling with shale during a piston downstroke, the other cylinder is charging shale to the retort during a piston upstroke. When this operation is completed, the pump carriage is moved horizontally

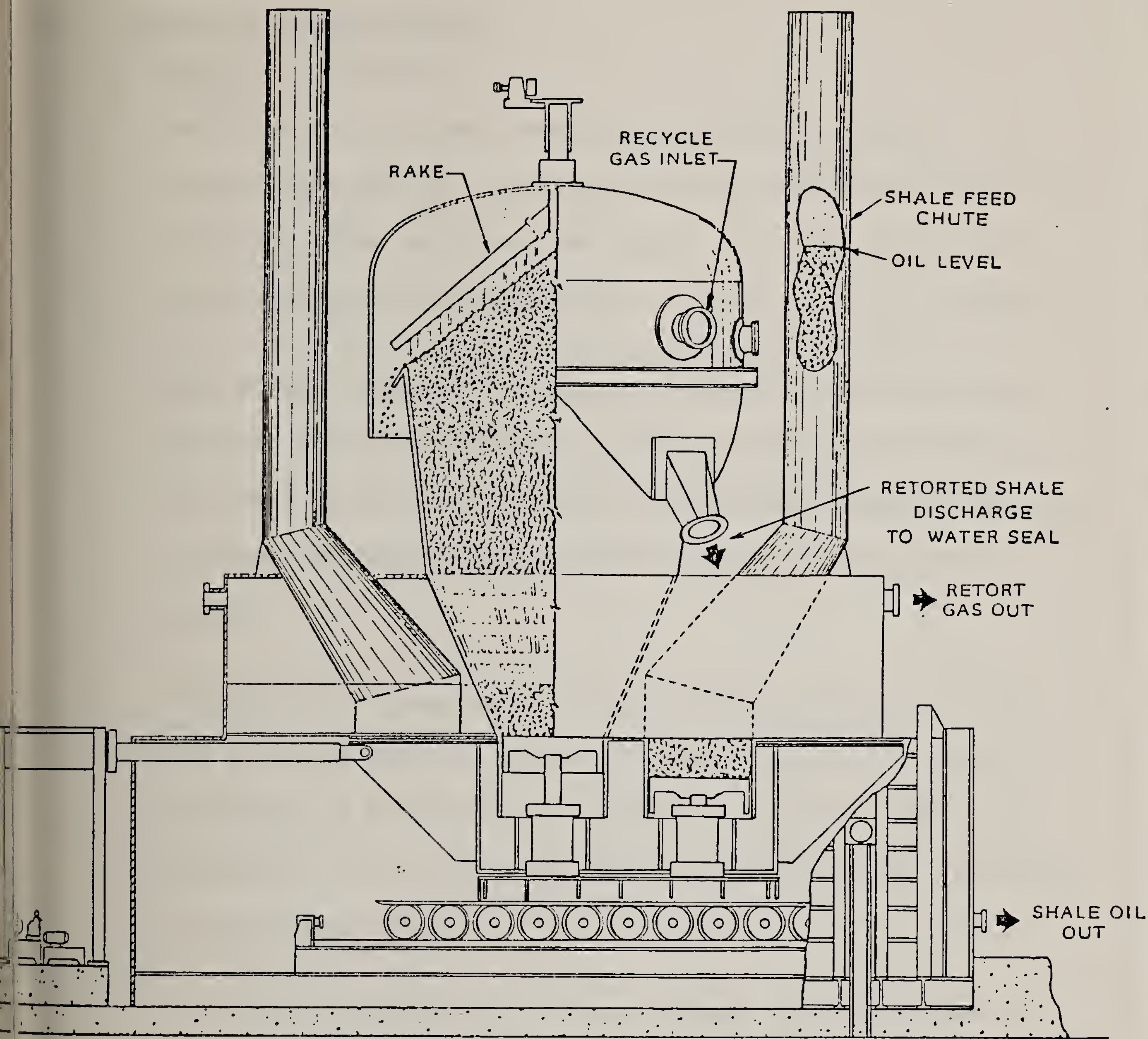


Fig. 11.2 UNION RETORT B

11.5 Alternate Retorting Methods

.2 Union B (Continued)

until the full cylinder comes under the retort. This cylinder charges its shale into the retort while the other fills with shale from the other feed chute. The carriage then is moved back into its original position and the cycle is repeated.

Seal plates outboard of each cylinder close off the idle feed chute to prevent discharge of shale into the feeder housing. The carriage and solids pump are hydraulically operated and rest on wheels which are guided on tracks during the horizontal travel.

Experience with pumping oil shale has shown that the cost of the equipment required is justified by the very considerable advantages of downward liquid flow and minimum agglomerating tendencies. The solids pump has been reliable based upon months of actual operation.

The shale is retorted as it rises through the retort cone by the countercurrent flow of hot recycle gas. As the retorted shale rises above the upper cone lip it forms a free-standing pile, the slope of which is governed by the angle of repose of the solids. A rake rotates just above the free-standing pile. Its purpose is to break up any agglomerates that may form.

11.5 Alternate Retorting Methods

.2 Union B (Continued)

The space above the upper cone is enclosed by the dome. The retorted shale slides down chutes and through the dome wall at the retorted shale outlets.

Hot recycle gas is introduced into the space between the free-standing retorted shale pile and the dome. It flows downward into the rising shale to provide the heat required for the retorting process. The oil shale kerogen decomposes into liquid and gaseous organic products which escape from the shale particles, and into a solid carbonaceaous reside which remains on the retorted shale. The bulk of the liquid product trickles down through the cool, incoming shale and the balance, in the form of a mist, is carried from the retort by the cold gases.

The gas and liquid are separated from the shale in the lower slotted wall section of the retort cone. In the disengaging section surrounding the lower cone, the liquid level is controlled by withdrawing the oil product. Recycle and make gas are removed from the space above the liquid level.

The shale particles which fall through the slots into the disengaging section are recycled by screw conveyors into the feed chutes. Very fine shale particles collecting at the bottom of the feeder case are pumped in an oil slurry back to the

11.5 Alternate Retorting Methods

.2 Union B (Continued)

retort by way of the disengaging section. The retorted shale is conveyed in pipes to one of the two retorted shale cooling vessels.

As shown in Figure 11.3, a level of shale is maintained above the level of water in the quench vessel. A drag-chain conveyor removes the cooled shale from under the water level. A water level is maintained in the conveyor to seal the retort pressure from atmosphere. Generated steam is condensed and returned to the cooling vessel. The cooled and wetted retorted shale is sent to disposal.

Gases from the disengaging section are scrubbed and cooled in a venturi scrubber. Agglomerated mist plus light ends and water produced by cooling are sent to an oil-water separator. The oil is recycled to the retort through the oil shale feed line and the water is sent to the water seal after stripping to remove ammonia. The scrubbed gas is divided into a make stream and a recycle stream. The recycle stream is compressed and heated prior to injection into the top of the retort.

Retort B produces a high yield of superior quality oil and a make gas with a high heating value. Retort B gas has an exceptionally high heat capacity, double that of gases produced in

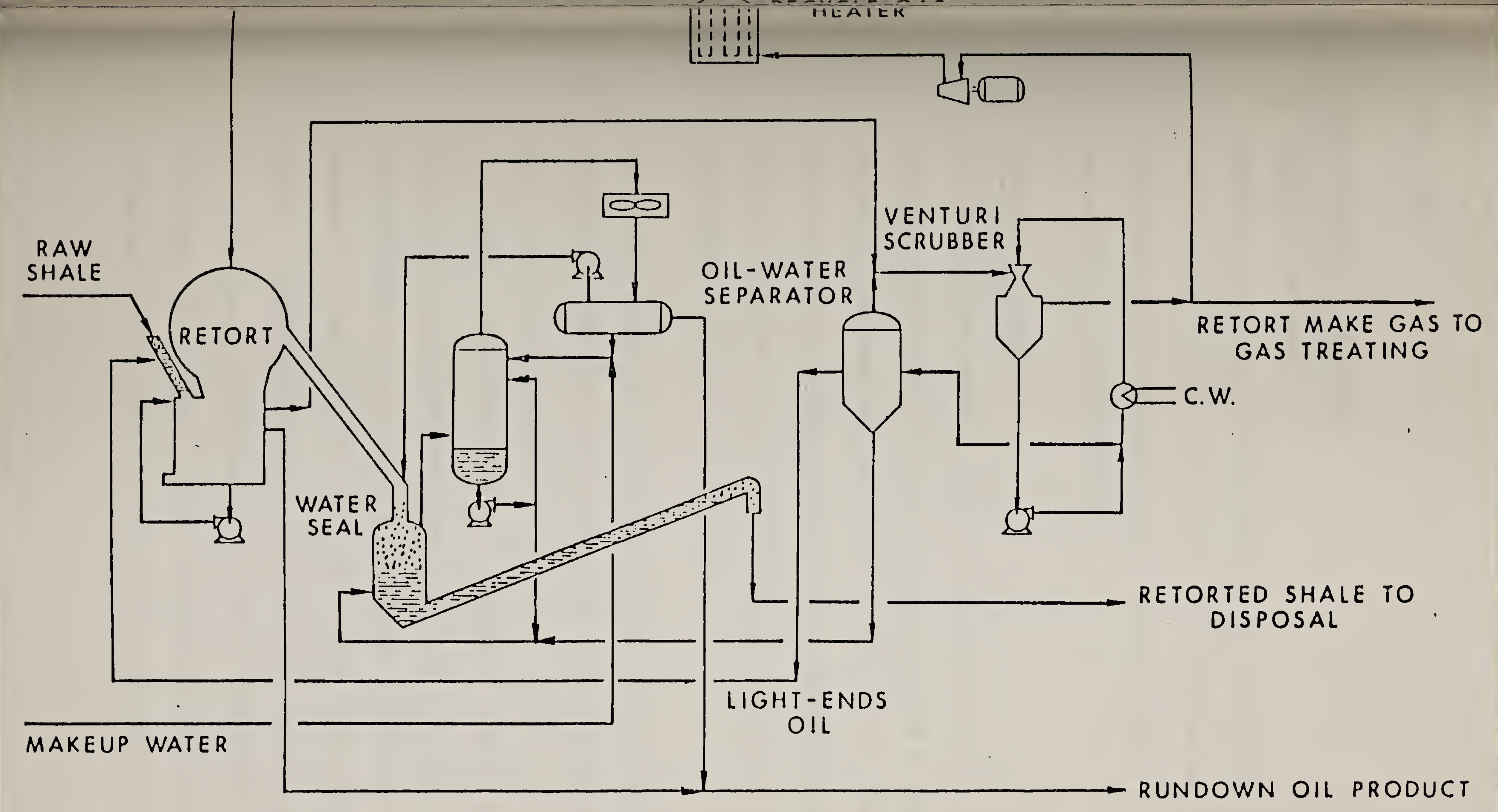


Fig. 11.3 RETORT B FLOW DIAGRAM

11.5 Alternate Retorting Methods

.2 Union B (Continued)

combustion processes, and the gas/solids heat transfer rates are correspondingly high. As a result, Retort B can be operated at solids mass velocities well over 1000 lbs/hr-ft^2 with a low pressure drop in the retort bed.

.3 Paraho Direct Heat

The Paraho Development Corporation developed an oil shale retorting process based on inventions and patents by John B. Jones, Jr. The technology has been applied in the calcination of limestone. A pilot plant has operated to produce over 100,000 barrels of Colorado shale oil that was refined into military products for the U.S. Departments of Defense and Energy.

The Paraho retort is a refractory lined, vertical shaft vessel for processing lump size shale nominal 3/8 to 3-1/2 inches. The process flow diagram is presented in Figure 11.4. The raw shale enters the top of the retort from a hopper. Inside the retort a rotating distributor places the shale evenly across the bed. The shale flows downward by gravity as a continuous moving bed. The movement is controlled by the unique grate in the bottom of the retort. In moving downward, the shale first passes the off-gas collector zone, then through a retorting zone (thermal decomposition of kerogen to oil vapor), over the gas distributors and through a cooling zone to the grate. The grate is operated hydraulically,

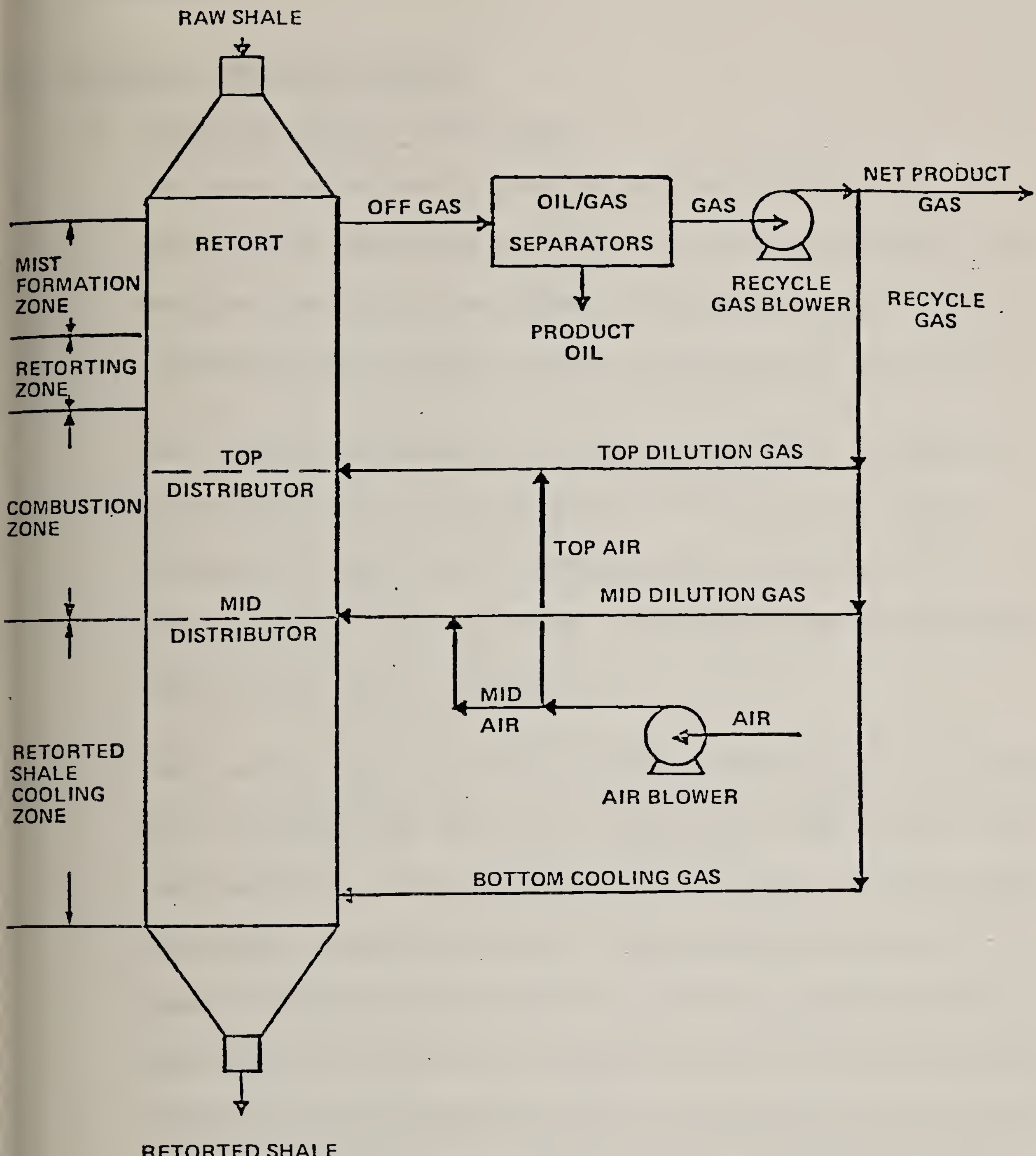


Fig. 11.4 PARAHO DIRECT HEATED RETORT

11.0 ALTERNATIVES

11.5 Alternate Retorting Methods

.3 Paraho Direct Heat (Continued)

Its speed controlled to give the desired flow of shale. The grate causes the column of material to descend uniformly over the cross-section of the retort. The retorted shale is discharged through a pressure seal at the bottom of the retort.

Cool recycle gas enters the bottom of the retort through gas distributors built into the grate. The gas, as it ascends through the shale bed, is heated by the descending retorted shale, which in turn is cooled. Additional heat enters through two levels of gas distributors.

Two levels of heat distribution are used to completely distribute heat uniformly over the retort cross-section and prevent cold gas channeling. The hot gases ascending above the distributors retort and preheat the shale. The ascending gases and oil vapors from retorting are cooled by incoming raw shale; oil is condensed in the form of a stable mist and carried by the gases through off-gas collection devices out of the retort to oil/gas separators for recovery of the oil and recycle of the gases. The Paraho retort is basically a counter-current gas-to-shale heat exchanger effecting high thermal efficiency.

In the direct heated process, coke in the retorted shale and some gas are burned in the retort by the addition of air at the

1.0 ALTERNATIVES

1.5 Alternate Retorting Methods

.3 Paraho Direct Heat (Continued)

distributors to heat the process. Recycle gas flows and air injection are controlled to provide enough hot gases to retort the shale in the zone above the top distributor. Air addition at the distributors is diluted by recycle gas to moderate high localized temperatures at the point of combustion. Products of retorting are gas and oil, plus retorted shale.

.4 Dravo Direct Heat

The Dravo Traveling Grate retorting process is based on Dravo's extensive pyro-metallurgical traveling grate experience. These reliable units have proven operating characteristics involving high temperature sintering, large grate areas and high throughputs.

This system is also economical and efficient for the handling and processing of large tonnages of material in oil shale retorting. The retort processes oil shale at a high rate under controlled heating conditions in an autogenous environment and recovers the maximum amount of oil possible. A usable off-gas is produced after separation of oil, water and particulates. The processed shale is cooled for disposal. Raw shale fines may be agglomerated and retorted along with the coarse oil shale.

11.0 ALTERNATIVES

11.5 Alternate Retorting Methods

.4 Dravo Direct Heat (Continued)

It is possible to process over 30,000 TPD on a single traveling grate of the size presently in operation. Oil recovery is approximately 99 percent of the Fischer Assay.

In the direct Dravo traveling grate oil shale retorting process, as shown in Figure 11.5a, sized oil shale particles are choke-fed to a circular traveling grate. The grate is sealed to prevent gases from leaving or air from entering the process.

Initially, the surface of the bed is heated up to retorting temperature. After the surface layer of shale is retorted, the shale passes to a second zone. Here cool gases mixed with air go to the bed. The air permits burning of residual carbon and some recycle gas, forming a combustion front which pushes a retorting zone ahead of it down through the bed. Cooling of the surface layers commences when the carbon is burned out of the shale.

Prior to the combustion front reaching the grate, air is shut off in a third zone and the bottom layers are retorted by direct heat transfer. Consequently, no oxygen reaches the windboxes under the grate. Meanwhile, cooling occurs in the upper regions of the bed.

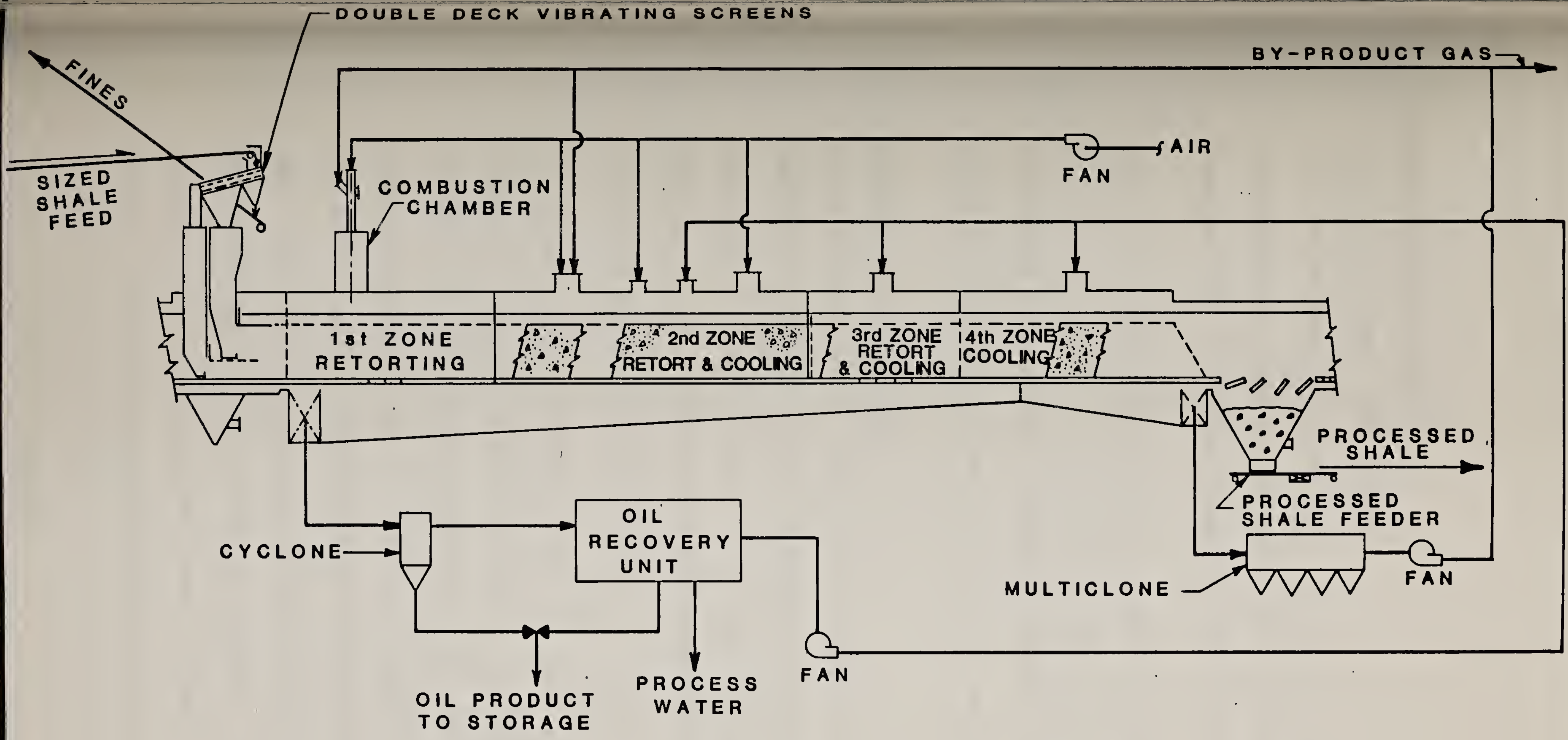


Fig. 11.5a DRAVO TRAVELING GRATE DIRECT HEAT

11.0 ALTERNATIVES

11.5 Alternate Retorting Methods

.4 Dravo Direct Heat (Continued)

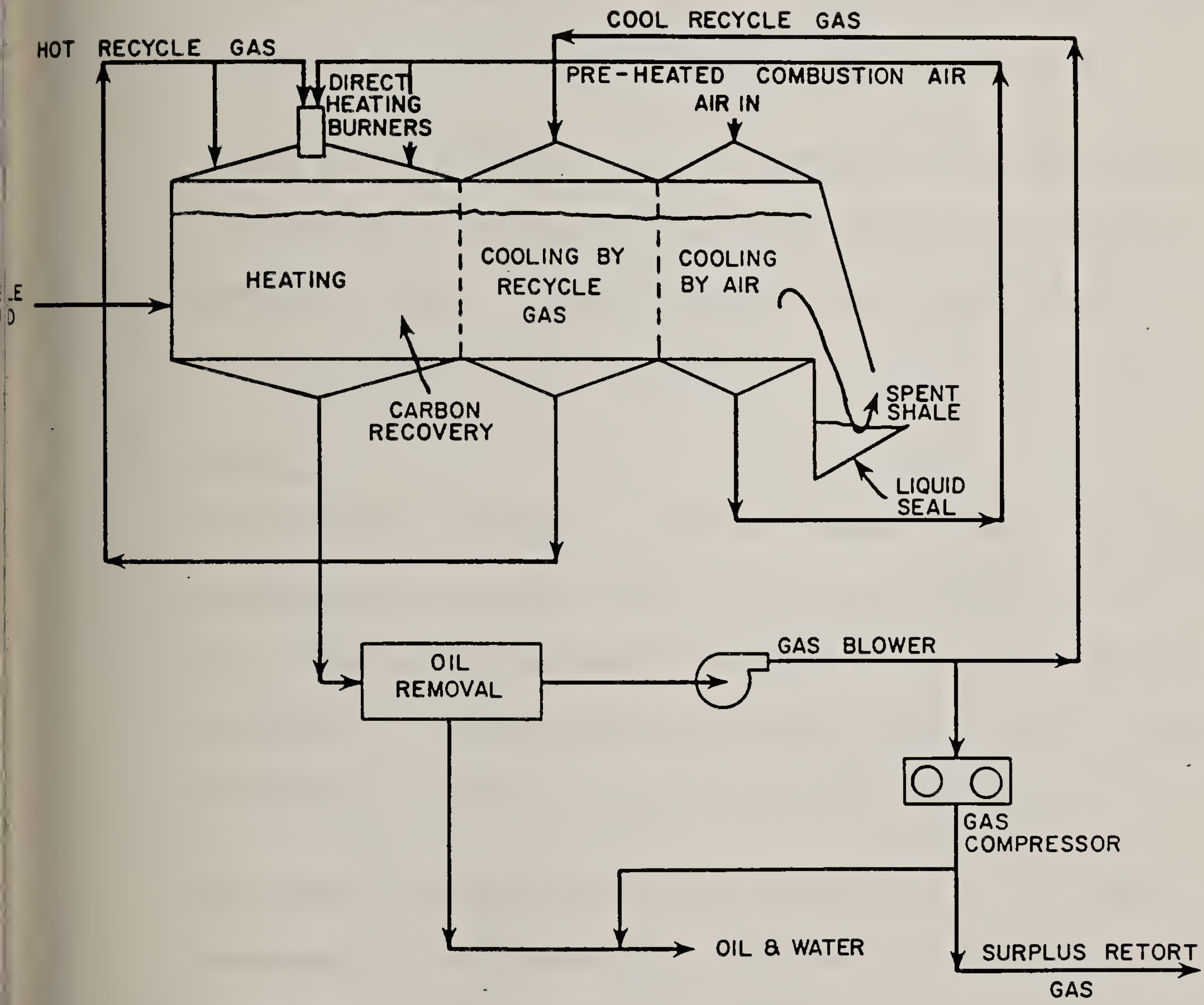
In a fourth zone, the cooling of the shale is completed prior to discharge. Shale is discharged dry from the machine to belt conveyors for collection, treatment and disposal.

The oil is removed from the gas stream in cyclones and a final oil recovery facility. The product gas can be used in steam generation for heating or producing power. Solids and water would be removed from the oil in the oil recovery facility.

.5 Superior Circular Grate

The Superior circular grate, like the Dravo unit, is based upon commercial designs used for many years in iron pellet sintering and other kiln applications. The design improvements made by Superior and contract engineering companies have converted the circular grate to a feasible shale oil retort.

It is this process (Figure 11.5b) the shale (1/4" by 4") is fed to a continuously rotating grate. The shale passes through inert gas purged mechanical seals and rotates into a heating zone (evolving oil, which is removed by a circulating gas heating media). Oil and water are removed by a circulating gas. The retorted shale then passes through a carbon recovery zone where the residual carbon is oxidized. The shale then passes through a cooling zone where it heats up recycle gas. Further cooling of the shale occures when it is contacted with



CIRCULAR PATH OF
SOLIDS BED IS PICTURED
A STRAIGHT PATH FOR
RITY.

FIG. 11.5b
SUPERIOR CIRCULAR GRATE
DIRECT-HEATED MODE

11.0 ALTERNATIVES

11.5 Alternate Retorting Methods

.5 Superior Circular Grate (Continued)

ambient air for use in direct fired burners (thus improving thermal efficiency). The processed shale is discharged either by mechanical seals or a water seal (wetting the shale for dust control). Combustion gases mix with preheated recycle gas, raising its temperature to 1250°F to 1500°F, and the mixture passes to the shale heating zone to complete its cycle.

Excess gas is collected from a slipstream of the recycle gas. This gas has a heating value of 80 to 130 BTU/SCF depending upon shale grade. The gas is compressed to about 50 psig and additional water and oil is removed.

.6 TOSCO II

In the TOSCO II process, crushed oil shale is heated to approximately 900°F by direct contact with heated ceramic balls. At this temperature, the organic material in oil shale rapidly decomposes to produce hydrocarbon vapor. Cooling of the vapor produces crude shale oil and light hydrocarbon gases.

The thermal decomposition reaction takes place in an inert atmosphere in a rotating kiln (referred to as the pyrolysis reactor or retort) shown in the central portion of Figure 11.6. The feed streams to the retort are 1/2-inch diameter ceramic balls heated to about 1100°F and preheated shale crushed to a size consist of 1/2-inch or smaller. The rotation of the retort mixes the materials and causes a high rate of heat

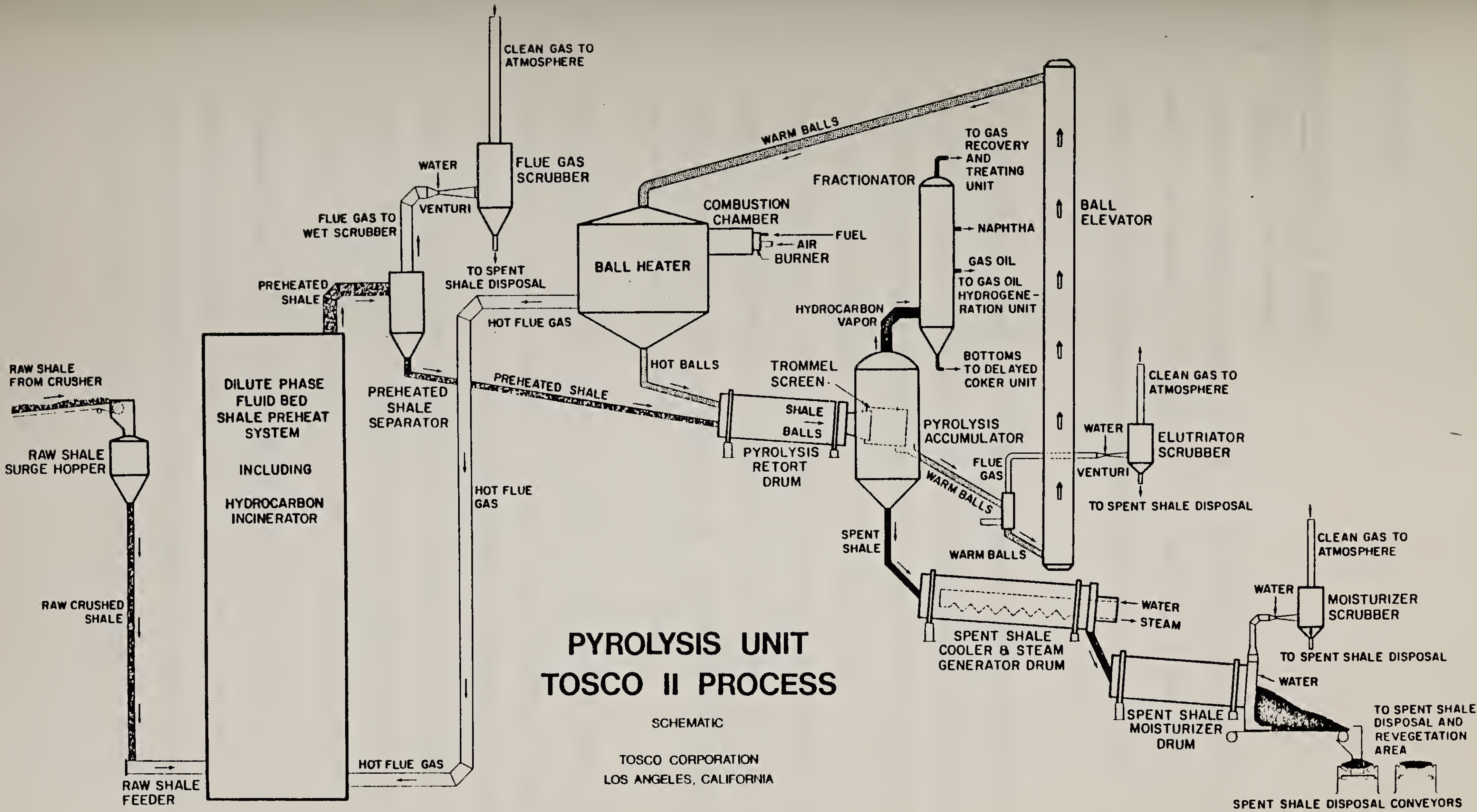


Fig. 11.6 TOSCO II FLOW DIAGRAM

11.0 ALTERNATIVES

11.5 Alternate Retorting Methods

.6 TOSCO II (Continued)

transfer from the ceramic balls to the shale. At the discharge end of the retort, the ceramic balls and shale are at substantially the same temperature, and the shale is fully retorted.

The hydrocarbon vapor formed by the retorting reaction flows through a separator to remove entrained solids and then into a fractionation system similar to the primary fractionator of a catalytic cracking unit. In the fractionator the oil vapor is cooled to produce heavy oil, distillate oils, naphtha and light gases. The non-condensable gaseous product from retorting has a high heating value and is suitable for upgrading to hydrogen or synthetic natural gas or for use as plant fuel.

The ceramic balls and retorted shale flow from the retort into a cylindrical trommel screen. Processed shale passes through the screen openings and into a surge hopper. The ceramic balls flow across the screen and into a bucket elevator for transport to the ball heater where they are heated by direct contact with hot flue gas. The ceramic balls are then recycled to the retort.

Processed shale, discharged from the retort at 900°F, is first cooled in a rotating vessel containing tubes in which water is vaporized to produce high pressure steam. It then flows to a rotating vessel in which it is further cooled by direct

11.5 Alternate Retorting Methods

.6 TOSCO II (Continued)

contact with water. The water flow is controlled to obtain about 10-15 weight percent moisture in the shale discharged from the vessel. The moisture is added to control dust emissions and to make the processed shale suitable for compaction.

As previously noted, the crushed oil shale is preheated prior to its entry into the retorting vessel. The preheating is achieved by direct contact of the crushed shale with the flue gas effluent from the ball heater.

The flue gas used to heat the ceramic balls and to preheat the shale is the principal gaseous effluent fromt he process. The process includes a wet scrubber system to control the particulate content of the gas and an incinerator to control its hydrocarbon content. Emission of oxides of sulfur and nitrogen are controlled by the selection of fuels used in the process and, in the case of nitrogen oxides, the firing temperatures and configurations of process heaters.

Tests in the pilot plant and semi-works plant have shown that the Tosco II process recovers substantially 100 percent of the recoverable hydrocarbon in oil shale as determined by the modified Fischer Assay procedure. Results from a seven day, continuous operating period of the semi-works plant, in which the plant was operated substantially at its design capacity,

11.5 Alternate Retorting Methods

.6 TOSCO II (Continued)

and operations were particularly directed to reliable measures of product yields, resulted in an average plant yield some 1.7 percent greater than produced by Fischer Assay of a composite sample of shale representative of the average plant feed during the operating period.

A typical analysis of the C_4 and lighter components projected to be produced in the TOSCO II retorting process would show the gas substantially free of nitrogen and containing only the amount of carbon dioxide produced by pyrolysis. Consequently, the gas is suitable for upgrading to SNG or hydrogen.

The pyrolysis unit requires fuel for its ball heater, incinerator and steam superheater. In the Colony design, high BTU fuel gas and some oil are used for fuel. In a hybrid pyrolsis plant, low BTU gas from gasification of raw shale or other sources could be used as substitute for essentially all of the fuel requirements of the ball heater and incinerator. With preheating of air and fuel gas, a fuel gas with a heating value as low as 115 to 120 BTU can be used in the ball heater and incinerator without supplemental fuel.

The raw water requirement is totally consumptive and is principally required to moisturize processed shale to permit construction of a stable disposal embankment. Foul water

11.0 ALTERNATIVES

11.5 Alternate Retorting Methods

.6 TOSCO II (Continued)

produced in the retort, or other low quality water, can be used for this purpose.

11.6 Shale Oil Upgrading

.1 Untreated Shale Oil

Raw shale oil has nitrogen, sulfur and oxygen impurities that can be detrimental to refinery processing and finished product specifications. The original amount of impurities is not only related to the shale source but also to the type of retorting process. Shale oil produced by surface retorting generally has more impurities than that produced in-situ due to higher yields of heavier fractions. The following data, averaged from Cameron Engineers' "Synthetic Fuels Data Handbook, Second Edition" 1978, shows this effect for Colorado shale oil:

	Average Oil Properties	
	Surface Retorting	In Situ Retorting
Number of Processes	6	2
Number of Samples	12	4
Physical Properties		
Gravity, °API	20.8	26.2
Pourpoint, °F	80	50
Vol percent at 1000°F Boiling Point	85	95
Impurities		
Nitrogen, wt. %	2.00	1.50
Sulfur, wt. %	0.75	0.68
Oxygen, wt. %	1.13	1.15

Raw shale oil must be pretreated at the refinery. Its commercial value would be determined by considering the refinery

11.0 ALTERNATIVES

11.6 Shale Oil Upgrading

.1 Untreated Shale Oil (Continued)

shale oil treating capabilities and costs relative to available crude oil.

.2 Hydrotreating

Two types of shale oil upgrading are available. Thermal processing is not considered a viable alternative for the C-b Tract due to reduced oil yields and incomplete impurity reduction. Hydrotreating is the preferred alternative; it is a proven catalytic hydrogen treating process that removes impurities by reaction and can even increase volumetric oil yields. Both processes reduce oil gravity and lower the oil pour point.

The following information from the "Oil Shale Data Book" prepared by TRW in June 1979, shows the effect of hydrotreating shale oil.

	Reference 2		Refernce 5	
Retorting Process	Unstated		Paraho	
Stream	Feed	Product	Feed	Product
Physical Properties				
Gravity °API	20.2	35.8	20.7	31.5
Pour Point, °F	90	-	75	70
Vol. % Yield, C_5+	-	-	-	102.6
Impurities				
Nitrogen, Wt.%	2.18	0.10	1.99	0.32
Sulfur, Wt. %	0.66	0.01	0.70	0.05
Oxygen, Wt. %	1.16	0.02	1.32	0.03

Upgraded shale oil, also called syncrude, has reduced impurities, improved yield characteristics, and can be processed by any

11.6 Shale Oil Upgrading

.2 Hydrotreating (Continued)

refinery without pretreatment. It would easily command a premium commercial value compared to normal crude oils.

Hydrotreating reactions accomplish the following:

1. Nitrogen reacts with hydrogen to produce ammonia. This is the most difficult reaction.
2. Sulfur reacts with hydrogen to produce hydrogen sulfide. This is an easy reaction.
3. Oxygen reacts with hydrogen to produce water. This is an easy reaction.
4. Olefins react with hydrogen to produce paraffins. This is an easy reaction.
5. Aromatics react with hydrogen to produce naphthenes. This reaction is incomplete.

Hydrogen consumption depends on the amount of nitrogen, sulfur and oxygen reduction and the olefin and aromatic saturation. The degree of reaction is called severity: mild, moderate and severe.

1. Mild hydrotreating is used to stabilize oil and to remove small quantities of sulfur. Nitrogen reduction is only 20 to 30%; hydrogen consumption is 200 to 400 SCF/bbl feed.
2. Moderate hydrotreating is used to produce synthetic crude stock with substantial impurity reduction. Nitrogen reduction is 75 to 95%; hydrogen consumption is 500 to 1500 SCF/bbl.

11.6 Shale Oil Upgrading

.2 Hydrotreating (Continued)

.3 Severe hydrotreating is used to make high purity, lower boiling products such as jet fuel and diesel fuel. Almost all impurities are removed and hydrogen consumption ranges to 2500 SCF/bbl.

The C-b Tract would most likely employ moderate hydrotreating. A typical process diagram is shown in Figure 11.7. Oil and recycle gas are heated and pass over the hydrotreating catalyst. Exothermic heats of reaction are controlled to minimize undesirable coking and cracking. Products are cooled and condensed. Purge gas and water contain reaction byproducts. Stabilized oil is the synthetic crude oil product. A mid-fraction of this crude oil could be recovered for local diesel/fuel oil use.

Hydrogen make up is supplied from an adjacent sited hydrogen plant. Usually a high quality fuel is steam reformed to produce hydrogen.

$$CH_4 + 2H_2O \quad CO_2 + 4H_2 \tag{1}$$

However, other carbonaceous fuels can be burned to carbon monoxide which is then shift converted to produce hydrogen.

$$2C + O_2 \quad 2\ CO \tag{2}$$

$$CO + H_2O \quad CO_2 + H_2 \tag{3}$$

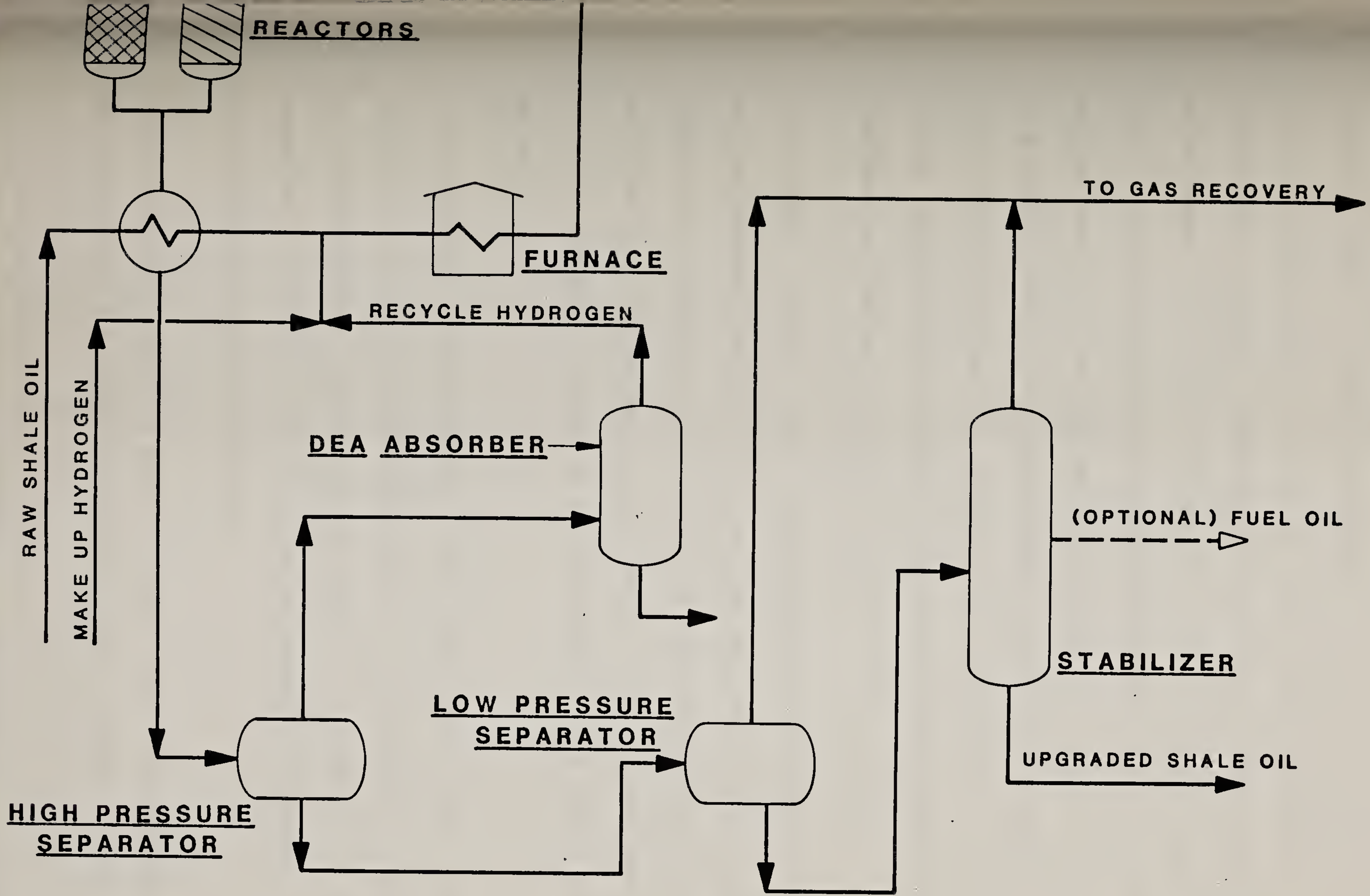


Fig. 11.7 HYDROTREATING FLOW DIAGRAM

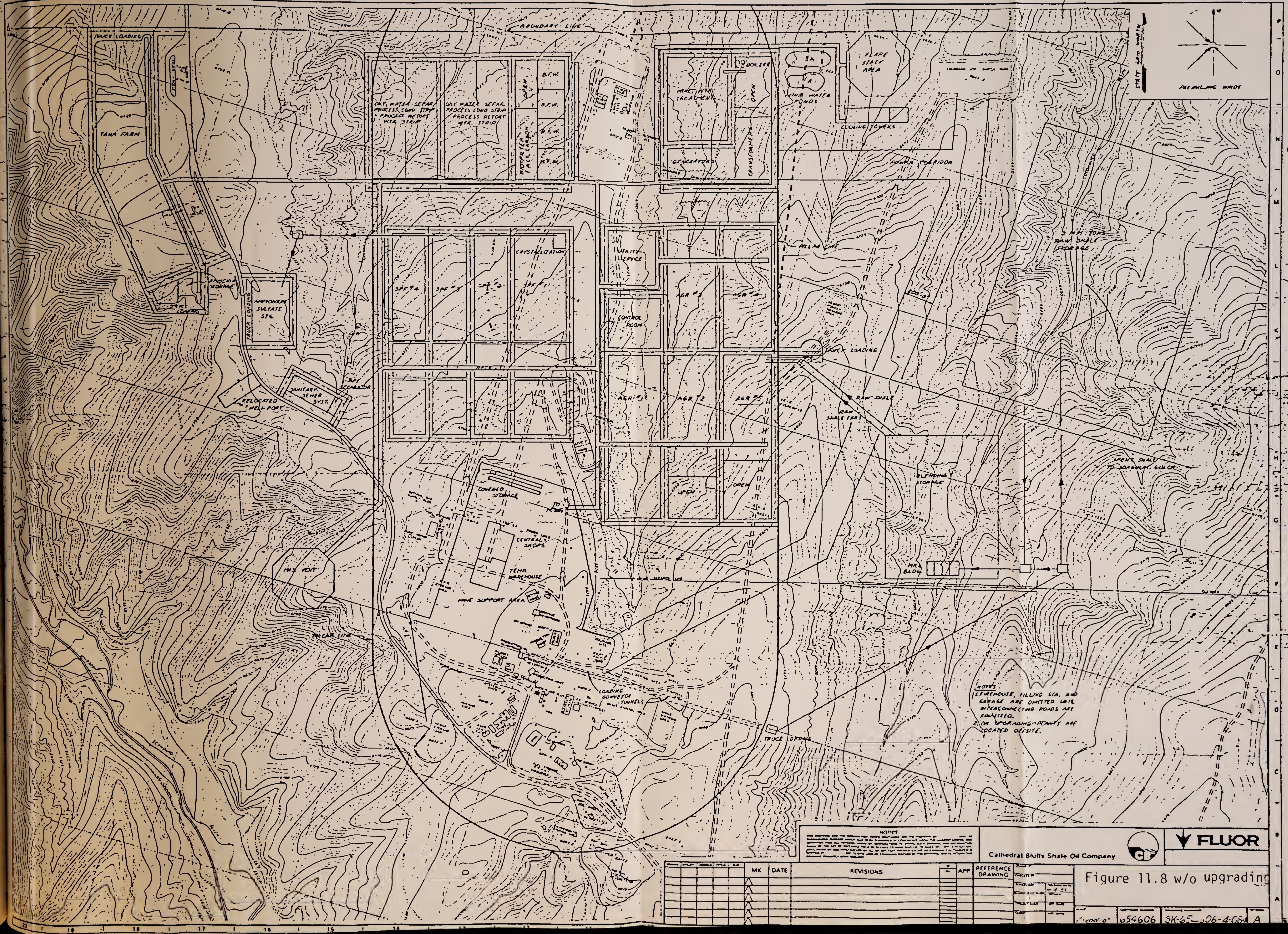
11.7 Alternate Surface Configurations

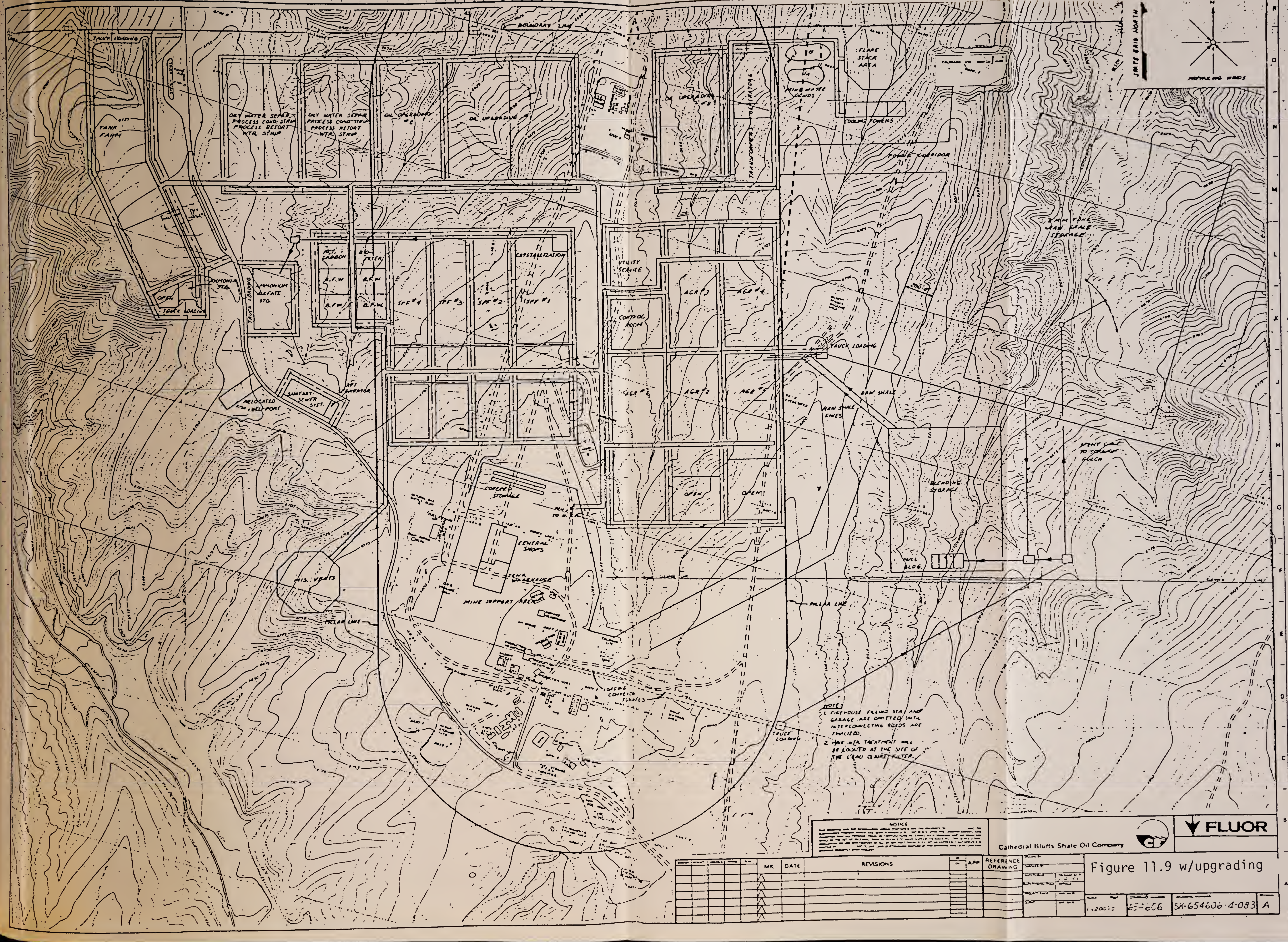
Full scale Tract C-b plot development is shown on Figures 11.8 and 11.9. The plans show facilities for a four train Modified In Situ retort gas collection, treating and utilization plant (SPF); Above Ground Retort units (AGR) with an installed capacity of approximately 69,000 tons of raw shale per day; oil/water separation facilities; turbine generators and mine water treatment facilities. Plot plan 11.9 shows a four train, 100,000 barrel per day oil upgrading facility (the decision for including the unit at C-b is pending). Further equipment for utilities, power generation, boiler feedwater treatment and emergency off-gas flaring is also included.

In all cases, the plot areas are considered conservative. The area requirements for the first SPF (SPF #1) and the first AGR (AGR#1) are increased since these units must be relatively self-contained in utilities and gas processing. Further development of utility areas will coincide with development of additional SPF and AGR units.

The plot area is limited by the size of the shaft pillars. The "pillar line" (shown on the plot plans) is the boundary of the pillar for the Production, Service and V/E shafts. This area will not be undermined and should incur very limited ground subsidence suitable for process equipment installation.

Other features of the plot plans include: easy access to the AGR for the raw shale from the Production shaft; a southern location for


BOUNDARY LINE
TRUCK LOADING
TANK FARM
FLARE STACK AREA
COOLING TOWERS
GENERATORS
TRANSFORMERS
OPEN
MINE WATER PONDS
CRYSTALLIZATION
UTILITY SERVICE
CONTROL ROOM
AGR #1
AGR #2
RAW SHALE
BLENDING STORAGE
COVERED STORAGE
CENTRAL SHOPS
MINE SUPPORT AREA
LOADING CONVEYOR TUNNELS
NOTICE
Cathedral Bluffs Shale Oil Company
FLUOR
MK
DATE
REVISIONS
APP
REFERENCE DRAWING
Figure 11.8 w/o upgrading


BOUNDARY LINE
TRUCK LOADING
TANK FARM
OIL UPGRADING #2
OIL UPGRADING #1
FLARE STACK AREA
MINE WATER PONDS
COOLING TOWERS
POWER CORRIDOR
PREVAILING WINDS
ACT. CARBON
BIO-FILTER
CRYSTALLIZATION
B.F.W.
SPF #4
SPF #3
SPF #2
SPF #1
AMMONIA STG.
TRUCK LOADING
UTILITY SERVICE
CONTROL ROOM
TRUCK LOADING
RAW SHALE
RAW SHALE FINES
SANITARY SEWER SYST.
OPEN
COVERED STORAGE
CENTRAL SHOPS
MINE SUPPORT AREA
PILLAR LINE
BLENDING STORAGE
NOTES
NOTICE
Cathedral Bluffs Shale Oil Company
FLUOR
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DATE
REVISIONS
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REFERENCE DRAWING
Figure 11.9 w/upgrading
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11.7 Alternate Surface Configurations

the SPF trains that minimizes gas drift development during early stages of development; a centralized control area; close proximity of mine water treatment to mine water source (the V/E shaft); close coupling of the generators and the transformers; location of both the MIS vent and the flare stack to minimize impact on the operating area; conservative plant spacing; centralized utility and water treating areas; and easy power access from an existing power corridor.

11.8 Alternate Mine Designs

.1 Underground Methods

Initial Retorting from North End. Rather than starting the MIS retorts in the center area of the C-b Tract, retorting could begin at the north boundary and progress south. This would have the advantage of mining up the natural drainage of the oil shale formation which slopes downward to the north.

Mining could be laid out with four panels abreast which would consolidate development and construction activities. Gas handling and ventilation would also be improved.

Disadvantage would include greater amounts of drifting from the shaft to the north boundary prior to first ignition and dislocation of the surface facilities from the center area of the tract. Some congestion may occur since all activities in the full production phase are relatively close together. With the basic scheme, the mine is split into two divided sections which spreads out the work areas.

11.0 ALTERNATIVES

11.8 Alternate to Mine Design

.1 Underground Methods (Continued)

Combination Room and Pillar with MIS. This alternative could produce a higher tonnage of material for early surface retorting and allow the MIS retort development schedule to be extended. More time would then be available between the startup of successive retorts to accommodate changes in retort design.

The room and pillar portion would conform to the design of the upper and lower voids. These two levels could be mined more in advance of the full retort development and would result in an average grade mined of 33 GPT vs 25 GPT when the Intermediate Void level is included.

Room and Pillar. With this method higher grade sections can be selected which would result in fewer tons being retorted for the same amount of oil produced. Cost per ton hoisted would be lower, but in order to produce the same amount of oil that the MIS produces, capacity of hoisting or other vertical conveyances would need to be increased by 50,000 to 80,000 tons per day. As an example of this production balance, consider the following:

Base Case (Phase I Production)

MIS	=	55,000 BPD
Surface Retort 60,000 TPD @ 24 GPT x 100% Recovery	=	34,000 BPD
Total Oil Production		89,000

Surface Retorting Only

125,000 TPD @ 30 GPT x 100%	=	89,000 BPD

11.8 Alternate to Mine Design

.1 Underground Methods (Continued)

Increase in Hoisted Material

125,000 TPD - 60,000 TPD = 65,000 TPD

This would increase the demand on surface processed shale disposal facilities and would probably result in a final cost per barrel of oil produced higher than the MIS cost.

Rooms 50 to 60 feet wide as generally used in the shallower mines may not be possible due to the higher amount of overburden, water, and rock fractures. Total extraction of material in the 290-ft MIS interval would be less than 10 percent.

These room widths would be more critical in a room and pillar operation since the areal advance per day would be much greater than required for the MIS. Rooms 40 ft wide with 60 ft x 60 ft pillars might be more realistic resulting in a 64 percent extraction ratio with a 40 ft mining height.

11.9 Alternate Surface Retorting and Processing Schedule

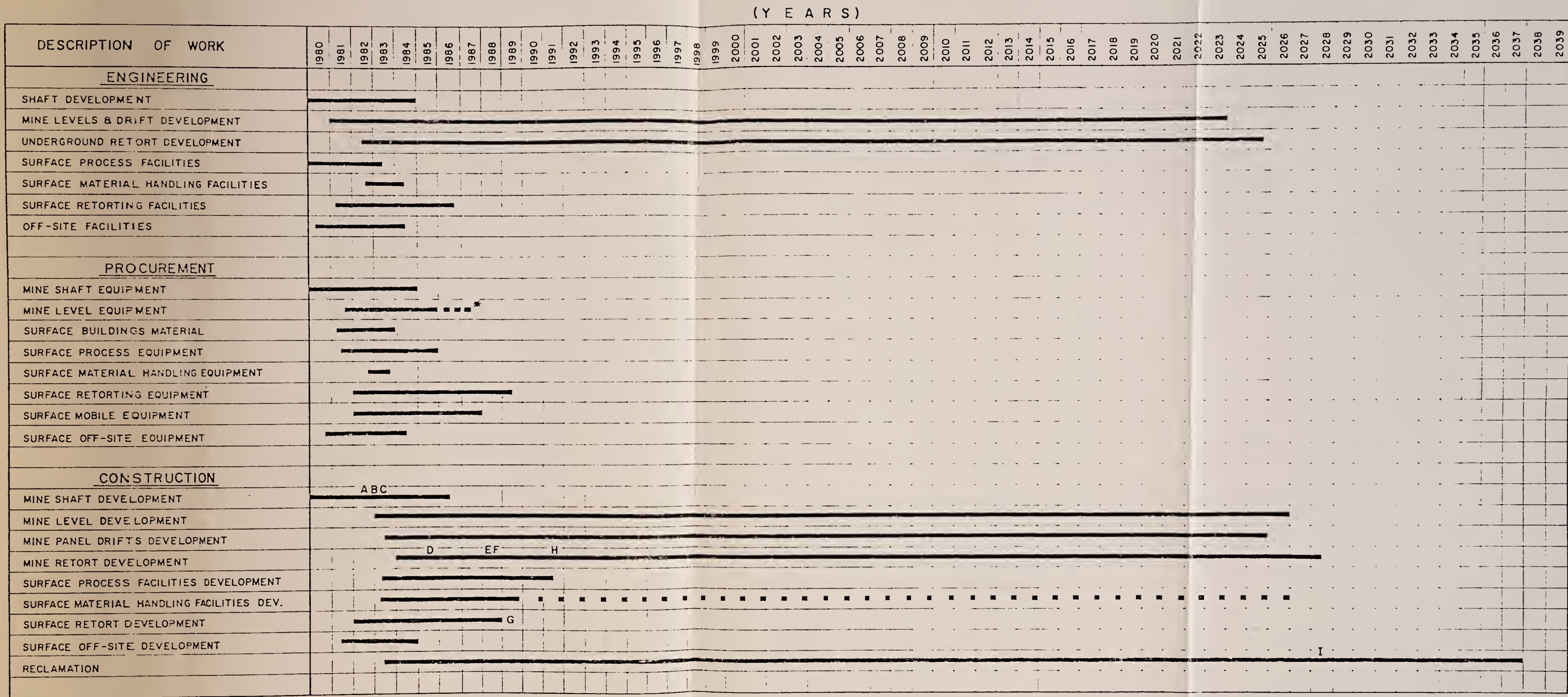
A modularized construction schedule is being considered by CB for for Surface Process Facilities and the Above Ground Retorts. According to this plan, the SPF will be built in four stages and four AGR units of 17,000 tons per day will replace seven of the previous units at 8,800 tons per day (See Section 11.7). The proposed development schedule for these facilities is as follows:

11.9 Alternate Surface Retorting and Processing Schedule

SPF	AGR
4 at 1/4 capacity	4 at 17,000 ± TPD
#1 - 9/1/85	#1 - 7/1/84
#2 - 3/1/89	#2 - 7/1/87
#3 - 3/1/90	#3 - 9/1/88
#4 - 4/1/91	#4 - 1/1/89

Figures 11.10 and 11.11 show the overall project development schedule as affected by this plan.

MASTER ENGINEERING, PROCUREMENT AND CONSTRUCTION DEVELOPMENT SCHEDULE



* IS A CONTINUOUS ACTIVITY THROUGH MINE DEVELOPMENT

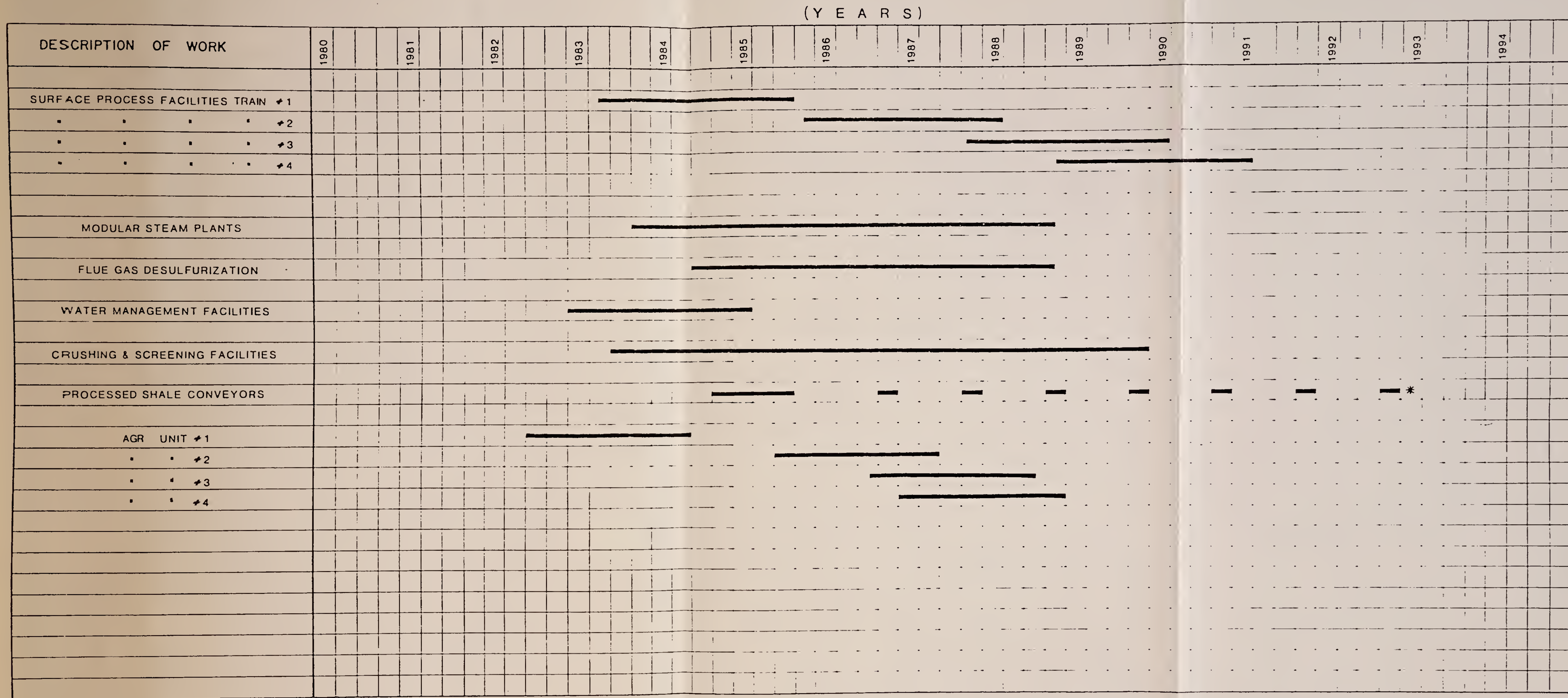
MILESTONES:

A. VENTILATION / ESCAPE SHAFT EQUIPPED AND FULLY OPERATIONAL.
B. PRODUCTION SHAFT EQUIPPED AND FULLY OPERATIONAL.
C. SERVICE SHAFT " " " " .
D. IGNITE FIRST IN SITU RETORT.
E. BEGIN PHASE II DEVELOPMENT.
F. FULL IN SITU RETORT OIL PRODUCTION.
G. SURFACE RETORT FACILITIES COMPLETED.
H. BEGIN PHASE III DEVELOPMENT.
I. END OF FIRST COMMERCIAL PHASE.

Figure 11.10 MASTER ENGINEERING, PROCUREMENT AND CONSTRUCTION SCHEDULE

SURFACE RETORTING & PROCESS FACILITIES

DEVELOPMENT SCHEDULE



* CONTINUOUS ACTIVITY THROUGH MINE DEVELOPMENT

Figure 11.11 ALTERNATIVE SURFACE RETORTING & PROCESS FACILITIES CONSTRUCTION SCHEDULE

12.0 CAPITALIZATION

12.1 Capital Cost Estimate

The capital cost estimate was developed for three areas: mining, including modified in-situ (MIS) retorting; surface processing, and aboveground retorting (AGR). The methods of estimating varied for each area depending on the type of capitalization. In the mining/MIS retorting area, equipment construction and mine development were estimated. In the surface processing and aboveground retorting areas, equipment construction was estimated. The steps taken in each estimate generally follow the estimating activity flow diagram in Figure 12.1. The total capital cost estimate is $3,887.4 million. The accuracy of this estimate is within 25 percent. Details of the total capital cost estimate are included in a confidential volume.

.1 Estimating Steps

Process flow diagrams for MIS retorting, surface processing, aboveground retorting, and mine plan drawings were prepared. A code of accounts was set to define a place in the estimate for all project items. Plot plans, sketches, and some equipment layouts were prepared for the process. The mine development schedule was determined and the work crews were defined for the mining activities. Equipemnt specifications were taken from the process flow drawings, sketches, and equipment layouts in order to prepare equipment lists. Vendor quotes were obtained for each piece of equipment. The installed cost of all equipment was calculated by adding costs for support equipment, matrials, labor, indirect costs, state taxes, and spare parts. Labor,

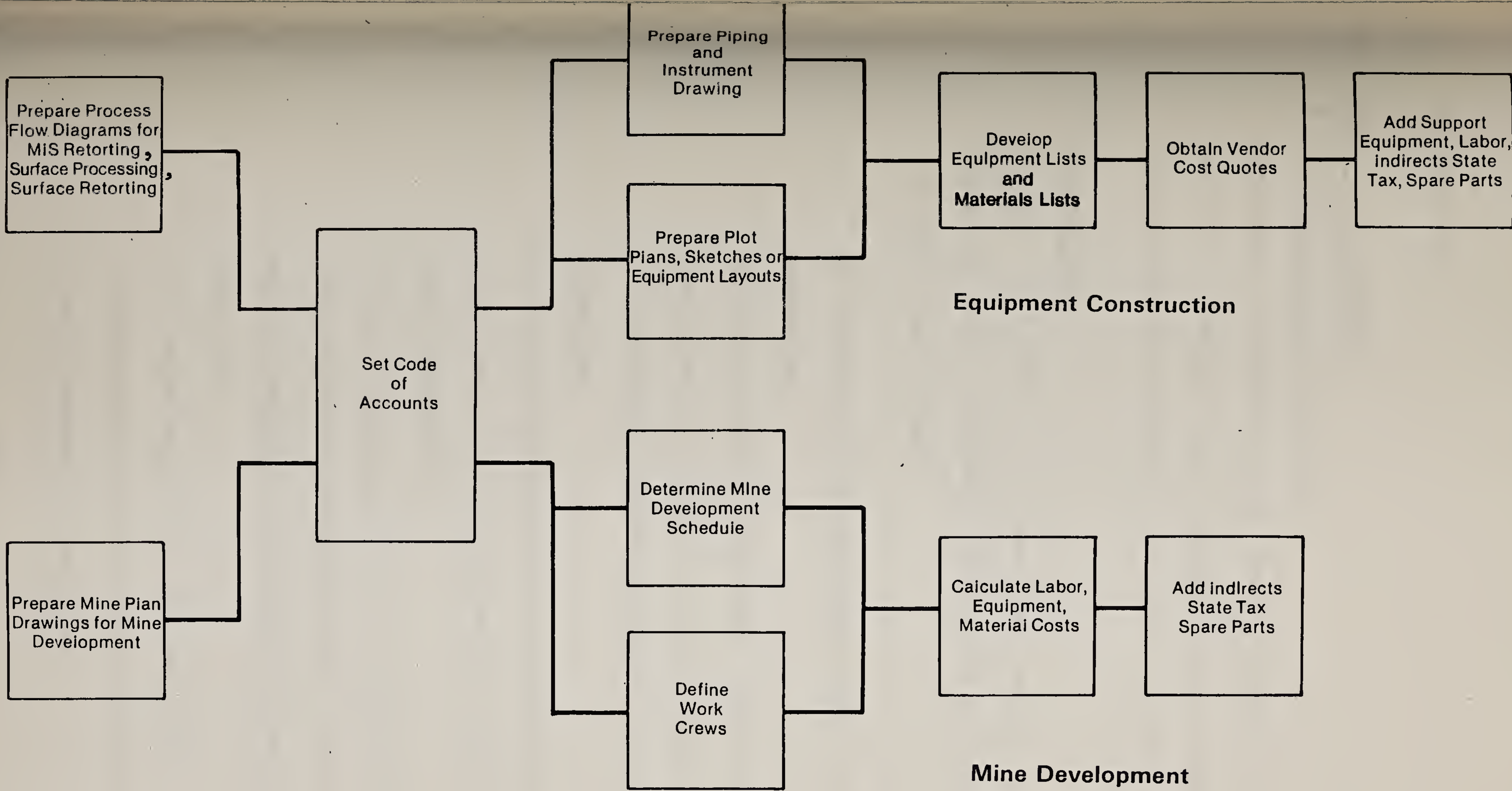


Figure 12.1 Estimating Activity Flow Diagram

12.0 CAPITALIZATION

12.1 Capital Cost Estimate

.1 Estimating Steps (Continued)

equipment, and material costs were calculated for the mine development activity. The total mine development cost estimate was obtained by adding costs for indirects, state tax, and spare parts.

.2 Direct Costs

Part of the capital cost estimate was prepared by determining the direct cost of equipment construction and mine development. The direct cost includes:

- All mining and mine development costs to the start of production.
- All mining and mine development costs from the start of production that relate to cluster expansion.
- All underground construction costs to the start of production.
- All underground construction costs from the start of production to full production that relate to cluster or facility expansion.
- All mine support buildings and surface facilities.
- Site construction management until full production.
- Project management and project engineering until full production.
- All surface Processing Facilities (SPF).
- All preproduction costs for each SPF and AGR train as it is being prepared for operation.

12.0 CAPITALIZATION

12.1 Capital Cost Estimate

.2 Direct Costs (Continued)

- All AGR facilities.
- All utility interface requirments for the AGR's.
- Site work.
- A variety of support piping to and from the SPF.
- Ten days storage for ammonia.
- Ten days storage for shale oil from the MIS retorts.
- Emergency power for the SPF and the AGR units.
- Injection pumps and water handling/treatment for excess mine water prior to SPF operations.
- Direct process support facilities and limited shift maintenance facilities.
- The high voltage power line from the mine to SPF.
- All raw and processed shale handling and crushing facilities.
- All construction labor and supervision wages.

The direct cost does not include:

- Costs for land or rights.
- Permits or licenses.
- Interest during construction.
- Escalation beyond the first quarter 1980.
- Labor incentives in addition to the fringe allowance.
- Personal property taxes.
- Ad valorem taxes.
- Rents or royalties.

12.0 CAPITALIZATION

12.1 Capital Cost Estimate

.2 Direct Costs (Continued)

- Shale oil storage for the AGR's.
- The product pipeline within the tract.
- The off-tract pipelines and tie-ins to nearby common carrier pipelines.
- Off-tract infrastructure requirements for permanent staff and temporary construction staff.
- Costs, fees, and royalities associated with obtaining permits, government approvals and lease rights.

.3 Indirect Costs

Indirect cost was determined and added to the direct cost. The indirect cost includes:

- Temporary construction facilities.
- Field staff expenses.
- Construction services and supplies.
- Field office supplies and expenses.
- Craft payroll burden.
- Construction camp and catering.
- Construction personnel transportation.
- Field administration.
- Small tools and consumables.

12.0 CAPITALIZATION

12.1 Capital Cost Estimate

.4 Contractor's Home Office Costs

Contractor's home office cost was calculated based on the amount of engineering work required to be performed. The fee is set as a percentage of the project cost.

.5 Colorado Sales/Use Tax

Colorado sales/use tax was calculated as three percent of the taxable items.

.6 Spare Parts

Spare parts were estimated based on the amount of equipment to be installed.

.7 Off-Site Capital Costs

Off-site capital costs include water pipelines and their related facilities. These costs are included in the capital cost estimate and are discussed in this section.

According to the present project plan, to obtain the maximum amount of water needed requires a diversion dam on the White River, a pumping plant, a pipeline from the White River to a storage on the C-b tract, and a pipeline from the C-b tract to 14 Mile Creek. To meet imported water needs, based on a production rate of 117,000 barrels/day, requires a maximum of 12,300 acre-feet per year in the 11th year. This need will be met with the White River-Piceance Creek pipeline, a 25 cfs pumping plant,

12.0 CAPITALIZATION

12.1 Capital Cost Estimate

.7 Off-Site Capital Costs (Continued)

and 4,000 acre-feet of storage. Cathedral Bluffs holds an option of water rights, with a 1966 priority, for diversion (100 cfs) and storage (76,000 a.f./yr) on the White River.

Table 12.1 summarizes capital costs for the water pipeline and related facilities.

TABLE 12.1 Capital Cost Summary for Off-Site Water Facilities (Grand Total Amounts - Thousands of Dollars)

Description		(First Quarter 1980)
White River Diversion Dam		1,500
White River Pumping Plant (25 cfs)		2,280
White River to C-b Tract Pipeline (21 miles of 30-inch diameter pipe)		9,980
C-b Tract Reservoir (4,000 acre-feet)		5,190
C-b Tract - Piceance Creek Pipeline (11 miles of 30-inch diameter pipe)		5,230
	TOTAL	24,180

.8 Environmental Costs

The following equipment has been included in the capital cost estimate and is considered necessary to meet required and/or desired environmental conditions:

12.0 CAPITALIZATION

12.1 Capital Cost Estimate

.8 Environmental Costs (Continued)

Dust Covers

Baghouses

Water Sprays

Scrubbers

Filters

Dust Collectors

Revegetation Equipment

Trash/Sludge Disposal

Flue Gas Desulfurization

Lurgi Gas Retorting

Various contractors developed capital cost estimates for the items listed above using their own estimating procedures. For instance, Fluor Engineering developed costs for trash and sludge disposal, VB Cook determined a variety of costs for underground mining operations, and Dravo Engineers also developed costs for underground operations and shale handling costs.

A capital cost summary listing necessary environmental equipment for underground and surface operations is given in Table 12.2.

TABLE 12.2 Capital Cost Summary for Environmental Equipment (Grand Total Amounts - Thousands of Dollars)

Description	(First Quarter 1980)
Dust Covers	582.1
Baghouses	755.1
Dust Suppression Systems	240.3
Fine Storage Silo and Filter	455.7
Scrubber Systems	130.0
Blenders and Sprinklers	519.7
Revegetation Equipment	699.4
Exhaust Shaft Stacks	180.0
Trash/Sludge Disposal	487.2
Lurgi Gas Retorting	45,000.0
Flue Gas Desulfurization	72,260.0
Dust Collectors	108.0
Water Spray and Scrubbers	107.0
Grand Total	121,524.5

13.0 STEADY STATE OPERATING COSTS

13.1 Introduction

The Steady State Operating Cost Estimate was developed for three areas: mining/modified in situ (MIS) retorting, surface processing, and aboveground retorting (AGR). The methods of estimating varied for each area depending on the type of operating cost. The total steady state operating cost is $511.3 million. Details of the total annual operating cost is included in a confidential volume.

13.2 Components of Steady State Operating Costs

The Steady State Operating Cost includes:

- Operating labor
- Maintenance labor
- Supervision
- Recruiting and training
- Maintenance materials
- Consumables
- Administrative expenses
- Power
- Mobile equipment repurchase
- Payroll burden

.1 Mining/MIS Retorting Area

In order to maintain full production of shale oil, a cluster of six retorts must begin retorting every 17.5 days. The costs associated with mining and constructing six retorts and with operating all retorts at full production were used as the

13.0 STEADY STATE OPERATING COSTS

13.2 Components of Steady State Operating Costs

.1 Mining/MIS Retorting Area (Continued)

steady state operating cost for 17.5 days. The annual operating cost was calculated from this basis.

.2 Surface Processing Area

The steady state surface processing operating cost was calculated for the first year of full production of MIS retort shale oil.

.3 Aboveground Retorting Area

The steady state aboveground retorting operating cost was calculated for the first year of full production of aboveground retort shale oil.

.4 Off-site Operating Costs

The off-site operating costs are included in the total operating cost and consist of the operation and maintenance of the water pipelines and facilities.

Operation and maintenance will be necessary for the White River diversion dam, the pumping plant, and various pipelines to meet Tract C-b's water needs. These are shown on Table 13.1.

.5 Environmental Costs

Steady state operating costs included in the total operating costs are presented here for environmental items as shown on Table 13.2.

13.0 STEADY STATE OPERATING COSTS

13.2 Components of Steady State Operating Costs

.6 Reclamation Costs

The estimate for the revegetation of the processed shale is included as a steady state operating cost. Reclamation costs are broken down in dollar per acre, as shown in Table 13.3.

TABLE 13.1 Operating Costs for Off-site Water Facilities (First 15 Years)

Description	Costs - Thousands of Dollars
Fixed Charges	4,352
Operation and Maintenance	234
Power Cost	114
Energy Cost	792
Total Annual Cost	5,492

TABLE 13.2 Steady State Operating Costs for Environmental Controls

Description	Annual Steady State Cost (Rounded) Thousands of Dollars
Baghouses	192.0
Fine Storage Silo Bin Filter	0.6
Scrubbers	28.2
Dust Suppression Systems	63.0
Sprinkler Truck	5.0
Flue Gas Desulfurization	6,111.0
Lurgi Gas Retorting (Emission Controls)	2,225.0
Trash/Sludge Disposal	458.5
Dust Collectors	40.6
Water Sprays	19.0
Scrubbers	39.5
Environmental Monitoring	700.0
Total	9,882.4

TABLE 13.3 Cost Estimate for Processed Shale Revegetation

Description	Dollars per Acre
Disposal of Processed Shale	Not Included
Contouring and Shaping	60
Topsoil Replacement	1600
Fertilizer	80
Plant Materials (Seeds and Transplant)	450
Mulch (Straw Harrowing)	175
Sprinkler System	90
Water (2 years)	490
Labor	180
Evaluation	75
Total	4200

14.0 SOCIOECONOMICS

14.1 Introduction

The combined social and economic effects of Federal lease tract development were described and evaluated initially in the 1973 Environmental Impact Statement (EIS) on the Prototype Leasing Program. The EIS included consideration for construction and permanent employement and associated personal income. The social costs of this economic growth were evaluated on both a site specific and regional basis, including effects on housing and related urban services, transportation, and schools. A two-volume Socioeconomic Assessment for development at Tract C-b was published in March, 1976 under the sponsorship of the then lessees, Shell Oil Company, and Ashland Oil, Inc.

To date, developmetn of the Federal lease tracts has not kept pace with the schedule outlined in the EIS. This has provided Piceance Basin communities with time for planning and construction of facilities which are adequate for the current, and expected near-term, population growth associated with oil shale development. Finaancing for these activities has been derived from a variety of sources, including in large part, Oil Shale Trust Funds and Energy and Mineral Impact Funds.

14.2 Base Condition

The location of the Cathedral Bluffs Project site will focus socioeconomic effects primarily upon communities in Western Garfield County and Eastern Rio Blanco County. This assumption has been

substantiated by the residency patterns of project workers as reported in quarterly monitoring studies during 1979-1980. The majority of project workers are expected to reside in Rifle (65%) while most of the remainder are expected to locate in Meeker (25%). A small percentage of project workers (10%) are expected to reside in other communities in the region, including Silt, New Castle, Parachute and elsewhere.

.1 Employment and Population

A breakdown of employment by industry sector for Garfield and Rio Blanco Counties is presented in Table 14.1. Employment in Garfield County is concentrated in wholesale and retail trade, government, and services. Government is a major employer in Rio Blanco county, as is mining. The majority of current mining employment in Rio Blanco County is associated with oil and gas exploration.

Future employment and population growth in the two counties is highly dependent upon the development of the area's energy resources. Trend population projection figures, displayed in Table 14.2, indicate a relatively slow rate of growth for the two counties and the communities of Rifle, Meeker, and Silt from 1980-1990. The trend figures were developed by the Colorado West Area Council of Governments (CWACOG), and reflect no major energy project development.

TABLE 14.1 County Employment by Industry

Industry	Garfield County Employment	Garfield County % of County Total Employment	Rio Blanco County Employment	Rio Blanco County % of County Total Employment
Agriculture	691	7.6	399	9.9
Mining	97	1.1	1892	46.9
Construction	961	10.6	159	3.9
Manufacturing	213	2.3	31	.7
Transporation, Utilities	820	9.1	258	6.4
Wholesale & Retail Trade	2267	25.1	346	8.6
Finance, Insurance, Real Estate	396	4.4	51	1.3
Services	1703	18.8	174	4.4
Government	1889	21.0	724	17.9
Total	9037	100.0	4034	100.0

Source: Colorado Department of Labor, Third Quarter - 1980.

TABLE 14.2 Trend Population Growth

Year	Garfield County	Rifle	Silt	Rio Blanco County	Meeker
1977	18,000	2,244	859	5,100	1,848
1980	19,985	2,316	896	5,324	1,886
1985	23,178	2,448	977	5,710	1,958
1990	25,823	2,585	1,066	6,067	2,044

Source: Region XI Population Projections 1980-2000, Colorado West Area Council of Governments, September, 1980.

14.2 Base Condition

.1 Employment and Population (Continued)

Employment projections which consider most energy resource projects proposed for development in Garfield and Rio Blanco Counties are displayed in Table 14.3. These projections were developed by CWACOG for area planning purposes, and include employment projections for coal, oil shale, and electric utility development. Cathedral Bluffs employment as forecast in early 1980 is included in the CWACOG compilation. An effort is underway on behalf of a combined State, local government, and industry task force to develop a cumulative forecast of employment and related population distribution for the Western Slope region. A report is planned toward year-end 1981.

The population projections of Table 14.4 are based on methodology outlined within the CWACOG report, and reflect high growth rates in Rifle and Meeker for the period 1980-1985, and a moderate rate of growth in Silt. Meeker is projected to increase in population at an average annual rate of 32.5 percent, Rifle at an average annual rate of 37.8 percent, and Silt at an average annual rate of 17.0 percent.

.2 Local Government Jurisdiction

A number of local government entities will be affected by the development of the Cathedral Bluffs Project including: counties, municipalities, school districts, and special purpose

TABLE 14.3 Energy Industry Direct Employment Projections 1980-2000

	1980	1981	1982	1983	1984	1985	1990	1995	2000
Colony	200	650	1900	3000	3250	2200	1450	1450	1450
Union		400	663	743	743	743	1395	1395	1395
C-a		450	600	1200	2500	3400	3700	3500	3500
C-b	450	600	1200	2500	3400	3500	3700	3500	3500
Superior			104	169	494	780	377	377	377
Snowmass/Anschutz	35	75	125	125	125	125	125	125	125
Colo-Wyoming	0	120	224	373	429	429	429	429	429
Northern Minerals	150	235	360	380	400	430	570	670	670
New Coal Leasing & Expansion				260	260	963	963	963	963
Colo. Ute	200	400	500	300	-1150	-1150	-1150	-1150	-1150
GEX/CMC	221	241	289	297	325	335	400	400	400
Sheridan	177	202	287	342	397	475	475	475	475
Mid Cont. Mesa II			72	140	160	207	207	207	207
Moon Lake I		282	329	537	481	414	414	414	414
Moon Lake II		396	513	884	691	474	474	474	474
Storm King	150	150	150	150	150	150	300	300	300

Source: Colorado West Area Council of Governments.
September, 1980

14.2 Base Condition

.2 Local Government Jurisdiction (Continued)

districts. The project site is within the jurisdiction of Rio Blanco County and the Meeker RE-1 School District. These are the only local jurisdictions which will receive direct property tax benefits. Other affected entities include Garfield County, and the towns of Meeker, Rifle, Silt, and Garfied School District RE-2. The sanitation district in Meeker, the hospital district in Rifle, and various other special purpose districts also exist within the vicinity of the project.

TABLE 14.4 Population Growth With Proposed Energy Projects

	Garfield County	Rifle	Silt	Rio Blanco County	Meeker
1977	18,800	2,244	859	5,100	1,848
1980	23,013	3,933	1,079	6,111	2,615
1981	27,837	5,661	1,268	9,230	3,650
1982	36,494	8,492	1,547	12,002	4,861
1983	45,440	12,516	1,943	14,343	7,031
1984	53,265	18,113	2,297	16,806	9,077
1985	55,694	19,573	2,361	19,392	10,693
1990	64,379	23,710	2,595	25,703	24,179

Source: Region XI Population Projects 1980-2000, Colorado West Area council of Governments September, 1980.

14.0 SOCIOECONOMICS

14.2 Base Condition

.3 Public Services and Facilities

Each of the communities in the project area have upgraded their capacity to provide public services and facilities in recent years.

The City of Rifle currently operates two water treatment plants: the Graham Mesa Treatment Plant and the Beaver Treatment Plant, located south of the city. In addition to the two treatment facilities, there are presently four storage facilities, including a recently completed 3.0 million gallon tank. A water system expansion program is underway in Rifle, and is scheduled to be completed by the end of 1981. The expansion will provide for growth of up to 16,000 persons.

Meeker's system was upgraded in 1976, and at current usage rates, it can provide for a population of up to 4,000 persons. Silt has recently begun construction on a $1.4 million program to upgrade its water system. Improvements should be completed by 1981, at which time the water system will have a design capacity of 2,800 persons.

The municipal sewage treatment facility in Rifle is currently operating beyond design capacity. However, plans are now being finalized to expand the facility to a treatment capacity of 1.04 million gallons per day, which would accommodate a population of about 10,000 persons. The Rifle Village South Metropolitan

14.0 SOCIOECONOMICS

14.2 Base Condition

.3 Public Services and Facilities (Continued)

District operates a lagoon treatment system which is currently capable of treating sewage for about 1,200 persons. This treatment system is capable of being expanded to twice that capacity as need arises.

The sewage treatment system in Meeker is currently capable of accommodating a population of up to 4,000 persons. Silt is in the process of designing a new sewage treatment plant which could serve up to 2,800 persons.

With water and sewage facilities which are either in place, or are schedule for construction in the near future, Rifle could accommodate in excess of 10,000 persons, Meeker up to 4,000 and Silt up to 2,800. These systems should be adequate through the mid 1980's.

Transportation has been a major concern to the three communities in their efforts to accommodate rapid growth. Rifle is planning a bypass route to relieve traffic congestion from Colorado 13 as it passes through town. Funding for construction will derive from a combination of Oil Shale Trust Funds, State highway funds, Energy Impact Assistance funds, and funds generated through a shale industry-sponsored nonprofit development corporation. Meeker is in the process of upgrading and improving drainage along Colorado 13, west of town. Silt, which presently

14.2 Base Condition

.3 Public Services and Facilities (Continued)

is without any paved streets, is seeking $2.7 million to pave the majority of streets in town.

Health care in the area is provided through Pioneer Hospital in Meeker and Clagett Memorial Hospital in Rifle. Both hospitals are presently utilized somewhat below capacity, and are planning for expansion as the need arises. In some areas, such as emergency room services, the recent demand for services has required that some expansion take place. An increase in the number of physicians in the area has also occurred recently. Other municipal services have been increasing steadily as population increases in the three communities. Rifle and Meeker have expanded their law enforecement staffs in the last year. Meeker has acquired additional firefighting equipment. Rifle has added two additional municipal staff memebers, a recreation director, and a planning director. Silt has added a planner, but continues to be short of personnel in the areas of law enforcement and public works.

.4 Public Education

Enrollment in the school districts which serve the communities of Rifle, Meeker, and Silt is displayed in Table 14.5 for June, 1980, including design capacity for each category of facility.

14.0 SOCIOECONOMICS

14.2 Base Condition

.4 Public Education (Continued)

TABLE 14.5 School District Enrollment and Facility Capacity - 1980

District	Enrollment	Design Capacity
Garfiled School District RE-2		
Rifle/Silt Elementary	822	690
Rifle Junior High	336	300
Rifle Senior High	572	475
Meeker School District RE-1		
Elementary	406	500
Junior High	130	250
Senior High	238	450

Source: Pace Quality Development Associates; and Cathedral Bluffs Shale Oil Project, Socio-economic Monitoring Report, June 1980.

Faced with current enrollments over capacity, and projected school-age population on the order of 4,500 students by 1984-1985, the District has embarked upon a building program as outlined in Table 14.6.

The completion of all of these building projects would give the school district the capacity to handle an enrollment of about 4,000. Each of the projects, with the exception of construction funds for the proposed elementary school site, have been financed through previous Oil Shale Trust Fund (OSTF) allocations or included in the 1981 request of $8,882,000. The School District request has been assigned highest priority at the county level.

TABLE 14.6 Garfield County District RE-2 Building Program

Project	Status	Capacity
Expansion of Rifle Jr. H.S. to be used as a Sr. H.S.	Final Stage of construction to be ready for occupancy in Spring 1981.	500
Expansion of Silt Elementary	Construction will begin in Spring 1981 and be completed by September 1981	100
Construction of new elementary school in north Rifle	Phase I - Construction began September 1980, due for completion Fall 1981.	300
	Phase II - Contained in 1981 Oil Shale Trust Fund Request	150
Addition to the New Castle School	Contained in 1981 Oil Shale Trust Fund Request	100
Construction of vocational education complex in Rifle	Contained in 1981 Oil Shale Trust Fund Request	N/A
Construction of new Jr./Sr. H.S. in the Silt-New Castle area	Contained in the 1981 Oil Shale Trust Fund Request - To be started in 1982 or later	650
Construction of additional elementary school	Site purchase only contained in 1981 Oil Shale Trust Fund Request - to be built after 1983	350

Source: Pace Quality Development Associates, October 1980.

14.2 Base Condition

.4 Public Education (Continued)

The Meeker School District has completed design work for expansion of the high school and for a new elementary school. They have also completed a land swap with the city for a future elementary school. Acquiring sites for future schools is a concern of the school district. The district has applied for a $125,000 grant which would allow purchase of sites for additional kindergarten, elementary school and high school facilities.

Standards are offered in Table 14.7 as an indication of additional requirements for school facilities as population expands.

TABLE 14.7 Estimated School Construction

	Population Level					
	10,000		15,000		20,000	
	Enrollment	Schools Needed	Enrollment	Schools Needed	Enrollment	Schools Needed
Elementary	1,650	3-4	2,475	5	3,300	6-7
Junior High	750	2	1,125	2	1,500	2-3
Senior High	1,650	2	2,475	2-3	3,300	2-3

Source: Rifle Comprehensive Framework Plan, March 1980.

.5 Housing

Table 14.8 displays the expected demand for additional housing units in Rifle, Meeker, and Silt from 1980-1990, given both trend population growth and population growth with proposed energy project employment from Table 14.4.

14.2 Base Condition

.5 Housing (Continued)

TABLE 14.8 Housing Demand

(Additional Dwelling Units)

Year	Trend Growth			Energy Development Growth		
	Rifle	Meeker	Silt	Rifle	Meeker	Silt
1980	47	12	19	143	113	67
1981	41	11	15	628	375	68
1982	41	11	16	1,029	440	101
1983	41	11	16	1,463	790	144
1984	41	11	16	2,035	744	129
1985	41	11	16	531	582	23
1986-1990	50	57	62	1,504	1,268	85

Estimates based upon 2.75 persons per housing unit.

Residential construction during recent years has averaged about 120 units per year in Rifle, 30 units per year in Meeker, and 10 units in Silt. This rate of construction could accommodate the trend demand for housing, but the rate of construction would have to be increased greatly in each community to provide for demand assuming energy growth projection. Both Rifle and Meeker have a number of subdivisions under development.

It has been recently estimated that based on an average density of five persons per acre, Rifle could accommodate up to 25,000 persons on land available for development within the area presently

14.0 SOCIOECONOMICS

14.2 Base Condition

.5 Housing (Continued)

served by municipal water and sewage treatment systems. Silt also has a large amount of developable land available. Overall, any limitations to housing development will involve public services rather than available land.

14.3 Effects of Cathedral Bluffs Project

.1 Employment and Population Growth

Cathedral Bluffs and Related Service Sector Employment. Projected annual employment and labor force related to the CB project are presented in Table 14.9. Total CB employment builds from about 360 workers at year-end 1980, to a peak force of around 4,800 in 1988. Long-term employment is expected to be on the order of 4,430 workers.

Estimates for service sector employment are derived using multipliers of 0.16 for bachelor quarter occupants, 0.5 for other construction workers, and a factor for permanent workers which increases stepwise from 0.75 to 0.90 over the 10-year interval. These values are in the same range as commonly used in projections for Sweetwater County, Wyoming; an area which continues to experience industrial growth associated with energy and mineral development, and which possesses a regional work force characteristic of that which can be expected to migrate into the CB project area.

TABLE 14.9 Annual Employment Related to the Cathedral Bluffs Project 1981-1991

Calendar Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Contractor	147	420	610	890	1040	1190	1410	1140	610	230	0
Cathedral Bluffs	216	560	1410	2030	3230	3300	3550	3830	4150	4430	4430
Total C.B.	363	980	2020	2920	4270	4520	4960	4970	4760	4660	4430
Service Sector[a]	225	613	1246	1818	2784	3004	3361	3727	3755	4013	3987
Total Employment	588	1593	3266	4738	7054	7524	8321	8697	8515	8673	8417
Overall Service/Basic Ratio	0.62	0.63	0.62	0.62	0.65	0.66	0.68	0.75	0.79	0.86	0.90
Labor Force [b]	604	1636	3354	4865	7244	7727	8546	8931	8745	8907	8644

Source: Cathedral Bluffs Estimate

[a] Service sector employment based on multipliers: 0.16 for bachelor quarter residents (1983=300; 1984=500; 1985-88=750; 1987=350); 0.50 for remainder of contractor personnel; and variable 0.75 to 0.9 for permanent work force.

[b] Unemployment rate = 2.7%

14.3 Effects of Cathedral Bluffs Project

.1 Employment and Population Growth (Continued)

Cathedral Bluffs-Related Population. Cathedral Bluffs-related population estimates are presented in Table 14.10. The estimates were done using statistics from Campbell and Sweetwater Counties, Wyoming; relating to members of workers, and average numbers of persons per household. The distribution of CB-related population is based in part upon worker surveys during 1979 and early 1980. Twenty-five percent of CB-related population is allocated to Meeker, in order to partially equalize the overall distribution from the current eleven percent of resident CB work force.

.2 Labor Supply

Construction and operation of the project will require a large number of skilled workers which are not currently available in the local labor force. To address this problem, Cathedral Bluffs intends to make training programs available, either in-house or through local institutions, to qualify individuals for required skills. This will enable many local residents to obtain employment with the project. It should also allow for more long-term opportunities for construction workers who will migrate into the area to obtain permanent project employment, which would reduce the movement of persons during the transition from construction to operation.

TABLE 14.10 Estimated Cathedral Bluffs-Related Population Distribution 1981-1991

Calendar Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Labor Force	604	1636	3354	4865	7244	7727	8546	8931	8745	8907	8644
Households[a]	416	1128	2106	3010	4479	4812	5377	5642	5790	6143	5962
Population [b,c]	1344	3643	6802	9722	14,467	15,542	17,367	18,224	18,702	19,842	19,257
Rifle	874	2368	4421	6319	9404	10,102	11,289	11,859	12,156	12,897	12,517
Meeker	336	911	1700	2431	3617	3886	4342	4556	4676	4871	4814
Other	134	364	681	972	1446	1554	1736	1809	1870	2074	1926

a Based on worker/household multiplier of 1.45 (Campbell County, Wyoming); adjusted for bachelor quarter occupants 1983=300, 1984=500, 1985-88=750, 1989-350.

b Population based on 3.23 persons/household derived from date for Campbell and Sweetwater Counties, Wyoming.

c Distribution=Rifle 65%; Meeker 25%; Other=Silt, Parachute, etc.=10%

14.3 Effects of Cathedral Bluffs Project

.3 Public Facilities and Services

The ability of local government public facilities and services to provide for future demand is highly contingent upon the rate of total population growth in the region. The uncertainty of population growth is caused by the uncertain development schedule of energy resource projects other than the Catnedral Bluffs Project, and over which Cathedral Bluffs has little control.

As indicated previously, communities in the region are working to expand facilities and services. Rifle has completed a comprehensive plan which closely examines all aspects of accommodating a population of 10-16,000 persons. Construction is currently underway to upgrade municipal water and sewage treatment facilities to that level.

Planning has begun to expand these systems even further. This construction is financed primarily through Federal and State grants. Rifle is continuously expanding its law enforcement and fire protection capacity with the addition of staff and acquisition of equipment. The hospital in Rifle is currently operating at a 38 percent occupancy level, which allows for some increase in utilization before major expansion is necessary.

The delivery of social services has been hampered in Rifle by inadequate financial resources. The delivery of social services generally suffers in rapid-growth communities because of the

14.3 Effects of Cathedral Bluffs Project

.3 Public Facilities and Services (Continued)

greater emphasis placed on expanding physical facilities. These services are supported on a countywide or statewide basis, however, which allows the advantage of a larger revenue base and a revenue base which benefits from industrial development.

Meeker is also planning for a greatly expanded population. A recently completed land use concept plan identifies the need to plan for a community of 8,000 persons. Current water and sewer treatment facilities are capable of accommodating a population of about 4,000. Additional capital improvements planning is underway which addresses a population of up to 11,500 persons. The local 17-bed-capacity hospital in Meeker is averaging less than 30 percent occupancy, but out-patient services are steadily increasing.

Silt will soon have adequate water and sewage treatment facilities for a population of 2,800 persons, or a population larger than that which the town is expected to attain by 1990.

Existing municipal facilities in all three communities are adequate to accommodate short-term growth in the area, but most excess capacity should be absorbed by the mid 1980's. Both Rifle and Meeker will require substantial facility expansion to accommodate population growth resulting from the combination of energy resource development proposed for the region.

14.3 Effects of Cathedral Bluffs Project

.3 Public Facilities and Services (Continued)

It is generally true that a minimum time period requred for the completion of a major public works project (i.e. water system, sewage system, street, drainage) in the area is about two years, assuming financing for the project is available. If financing for public projects continues to be available through sources such as those discussed in the following section, public sector expansion should be capable of keeping pace with private sector development.

Basic requirements for treated water, sewage treatment, law enforcement and hospital services in the communities of Rifle, Meeker, and Silt as a result of the project are shown on Table 14.11.

TABLE 14.11 Increased Demand for Municipal Services Resulting from the CB Project - 1980-1990

	RIFLE	MEEKER	SILT	OTHER AREAS
Treated Water[a]	3.848 MGD	1.603 MGD	.642 MGD	.320 MGD
Sewage Treatment [b]	1.099 MGD	.485 MGD	.183 MGD	.093 MGD
Law Enforcement[c]	22 officers 11 police vehicles	9 officers & 4 police vehicles	4 officers & 2 police vehicles	- - -
Hospital[d]	399 additional beds	13 additional beds	(Included in Rifle Estimate)	-

Source: Pace Quality Development Associates, October, 1980.

a Based on average day consumption of 350 gallons per capita.
b Based on average day effluent of 100 gallons per capita.
c Based on standard requirement of two officers and one police vehicle per 1,000 persons. Population based on 10,000 persons.
d Based on standard of three hospital beds per 1,000 persons in the service area. Population based on 10,000 persons.

14.3 Effects of Cathedral Bluffs Project

.4 Public Education

Projected growth in school enrollment in each local school district resulting from the project is presented in Table 14.12. The actual age distribution of children of current project workers who are immigrants to the area were used in these calculations. The project will generate a substantial increase in school enrollments, particularly within Garfield School District RE-2.

Preschool	-	37%
Elementary	-	42%
Junior High School	-	12%
Senior High School	-	9%

.5 Public Sector Costs

Estimated capital costs of expanded public services and facilities are detailed in Table 14.13. These costs are grouped according to the local jurisdiction (muncipality, county or school district) which has responsibility for the particular public service.

Applying the per capita cost figures to the projected population increases due to the project yields estimated costs of public facility and service expansion of $180,653,000 as displayed in Table 14.14. These capital investment costs reflect an estimate based upon a permanent population of 18,325.

14.3 Effects of Cathedral Bluffs Project

.5 Public Sector Costs (Continued)

No attempt has been undertaken toward estimating additional operating costs. These will be significant, but are not readily obtained owing to the large number of variables involved, and are keyed to the level of services which the public expects.

TABLE 14.12 Projected Increases in Local School Enrollment as a Result of the CB Project (Includes Both Direct and Secondary Populations)

Year	Garfield School District RE-2*	Meeker School District RE-1	Other Areas	Total
1979	140	30	20	190
1980	185	50	20	255
1981	210	60	20	290
1982	450	140	40	630
1983	1055	355	90	1480
1984	1520	480	135	2135
1985	2450	790	205	3445
1986	2525	815	215	3555
1987	2745	880	235	3860
1988	2905	950	240	4095
1989	2805	955	220	3980
1990	2980	1045	220	4245
1991	2890	1030	205	4125

Source: Pace Quality Development Associates, November 1980. (Revised June, 1981)

*Includes Rifle and Silt

TABLE 14.13 Itemized Estimates of Public Facility and Service Costs

(Per Capita Capital Costs for a Population Base of 10,000 Persons - 1980 Dollars)

Muncipal Services		Capital Investment
1. Water System		$ 395.00
2. Sewage Treatment		426.00
3. Storm Drainage		144.28
4. Solid Waste		13.88
5. Open Space and Recreation		372.42
6. Government Regulation		34.63
7. Planning		330.80
8. Police		29.56
9. Fire		148.17
10. Library		73.87
11. Health and Medical		210.84
12. Municipal Streets and Roads		1,836.00
13. Cemeteries		10.83
14. Other (5% of total)		201.31
	Total	$4,227.59

County Services		
1. County Roads and Highways		$1,035.00
2. Mental Health		-
3. Develpment Disabilities		-
4. Physical Rehabilitation		-
5. Social Services		1,090.00
6. Public Health		-
7. Elderly Services		-
8. Juvenile Corrections		-
9. Adult Corrections		-
10. Other (5% of total)		227.33
	Total	$2,352.33

School District Services		
1. Preschool		$ 170.83
2. Elementary		1,197.34
3. Junior and Senior High		1,225.00
4. Vocational-Technical		834.75
5. Higher Education		306.72
	Total	$3,734.64

Source: Oil Shale Tract C-b, Socioeconomic Assessment, Volume II Impact Analysis, C-B Shale Oil Project. Figures updated to 1980 dollars using implicit price deflators for local government expenditures.

14.3 Effects of Cathedral Bluffs Project

.5 Public Sector Costs (Continued)

TABLE 14.14 Estimated Cost of Public Facility and Service Expansion Due to CB Project Construction (1980 Dollars)

		Capital Investments
Garfield County[a]		$ 31,257,000
School District RE-2[b]		47,915,000
Rifle		46,482,000
Silt		7,758,000
Rio Blanco County		10,774,000
School District RE-1		17,105,000
Meeker		19,362,000
	Total	$180,653,000

[a] Assumes Rifle, Silt and 50 percent of growth in other areas.

[b] Assumes Rifle and Silt only.

.6 Community Economic Benefits

Construction and operation of the Cathedral Bluffs Shale Oil Project will contribute increased wage and salary income to nearby communities over the project life. Average construction worker wages are expected to be $27,000 annually (1980 dollars), while operations workers are expected to earn an average of $22,000 annually (1980 dollars). These wages are significantly higher than the existing overall wage in the area. An estimated local total payroll of $3.1 billion will be generated by the

14.3 Effects of Cathedral Bluffs Project

.6 Community Economic Benefits (Continued)

project. Employees in the support sectors, whose jobs are generated by project operation, are expected to earn an average wage of $15,500 annually (1980 dollars). An additional local payroll of $1.9 billion annually will be generated in local service sector jobs, for a total project-related local payroll of $5.8 billion. Table 14.15 is a tabulation of both direct and indirect annual local payroll generated by the project. The payroll figures are allocated by the expected residence distribution of project workers and secondary service jobs.

Local government jurisdictions will benefit from the project through increased tax revenues. The project will contribute property taxes directly to Rio Blanco County and the Meeker School District. Other entities of local government will benefit through individual property taxes, sales taxes, and other local government taxes and fees.

The State of Colorado will collect increased corporate income, sales, use, and severance taxes from the project. The State will also receive increased individual income taxes, highway users and other taxes from project employees and service sector employees whose jobs are generated by the project. In addition, Colorado will receive 50 percent of all mineral royalty payments made to the U.S. Government.

TABLE 14.15 Additional Local Wage and Salary Income Resulting From CB Project Operation (Direct and Secondary Employment) (1980 Dollars)

Year	Rifle	Meeker	Silt	Other Areas
1980	7,097,000	2,957,000	1,182,000	591,000
1981	9,161,000	3,817,000	1,527,000	763,000
1982	25,207,000	10,503,000	4,201,000	2,100,000
1983	39,972,000	16,655,000	6,662,000	3,331,000
1984	63,060,000	26,275,000	10,510,000	5,255,000
1985	94,590,000	39,412,000	15,765,000	7,882,000
1986	96,700,000	40,292,000	16,117,000	8,058,000
1987	99,188,000	41,328,000	16,531,000	8,266,000
1988	94,305,000	39,294,000	15,718,000	7,859,000
1989	91,590,000	38,163,000	15,265,000	7,632,000
1990	89,835,000	37,431,000	14,972,000	7,486,000
1991 - 2014	2,293,900,000	955,800,000	382,300,000	191,200,000
Total	$3,004,605,000	1,251,927,000	500,750,000	250,423,000
Grand Total				$5,007,705,000

Source: Pace Quality Development Associates, November 1980.

14.3 Effects of Cathedral Bluffs Project

.6 Community Economic Benefits (Continued)

Table 14.16 is an estimate of tax revenues accruing directly to local government entitites as a result of the project. These figures include only corporate property taxes, individual property taxes, individual sales taxes, and special purpose fees. They do not include any transfer of revenues which might occur between State and local governments, or Federal and local governments. The corporate property taxes are based upon an estimated value of surface improvements and gross revenue for the project. A 15-month time lag between valuation for assessment and property tax payment is included in the calculations. Individual property taxes are based on the assumption that each temporary wage earner (construction) will contribute 1.5 times his annual salary in local real property value, and each permanent wage earner will contribute 2.5 times his annual salary in real property value. This property value is discounted by 60 percent to account for the assessment at 1973 level of value required by State law, and assessed at 30 percent for tax purposes. The 1980 mill levies for each local jurisdiction are kept constant throughout the projection. Individual sales taxes assume 59 percent of gross income available for retail sales and that construction workers would spend 25 percent of this income locally, while permanent workers would spend 60 percent of it locally. The 1980 sales tax rates are held constant throughout the projection.

14.3 Effects of Cathedral Bluffs Project

.6 Community Economic Benefits (Continued)

TABLE 14.16 Projected Direct Tax Revenues Accruing to Muncipalities, Counties, and School Districts as a Result of the CB Project

	1980-1985	1986-1990	1991-2014	Total
Garfiled County[a]	$1,855,000	4,390,000	22,033,000	28,278,00(
School District RE-2[b]	3,266,000	7,754,000	39,100,000	50,120,00(
Rifle	2,526,000	7,088,000	35,319,000	44,933,00(
Silt	638,000	1,486,000	7,455,000	9,579,00(
Rio Blanco County	3,624,000	27,747,000	132,805,000	161,176,00(
School District RE-1	20,748,000	122,450,000	773,647,000	916,845,00(
Meeker	621,000	1,734,000	8,875,000	11,230,00(

[a] Assumes Rifle, Silt and 50 percent of growth in other areas.

[b] Assumes Rifle and Silt only.

Cathedral Bluffs estimates that a total of $1,281,000,000 in corporate property taxes will be paid to local government through the year 2014.

In comparing public sector costs of Table 14.14, and estimated revenues from Table 14.16, some understanding can be gained of the costs of growth to local governments versus the revenues produced by the project. It should be understood when making the comparison that all local property and sales tax revenues cannot be committed solely for capital requirements, but they are the major revenue sources available to finance these.

14.3 Effects of Cathedral Bluffs Project

.6 Community Economic Benefits (Continued)

School District RE-1 in Meeker, the jurisdiction which will benefit most from the corporate property taxes paid, should be in a strong position to meet capital expenditure requirements from early on. The School District will likely be able to reduce its property tax rate in later years because of the large amount of revenue generated by the project. Rio Blanco County should also receive large tax benefits from the project, which will allow it to reach an equilibrium with its expenses in the mid-1980's. The current, relatively low, tax rate imposed by Rio Blanco County will likely be preserved.

In the absence of some form of legislation to amend current revenue distribution, Garfield County and School District RE-2 will not benefit directly from the industrial tax base resulting from the project, but should receive significant sales tax revenue as a result of population growth. The two entities will likely require some financial assistance for capital projects during the period of construction and initial project operation.

The three municipalities of Meeker, Rifle, and Silt are expected to have difficulty meeting facility costs in future years. The municipalities will not benefit directly from

14.3 Effects of Cathedral Bluffs Project

.6 Community Economic Benefits (Continued)

any industrial tax base and sales tax revenues will increase at a slower pace than population growth. Meeker is projected to be in a long-term deficit postiion because its current sales tax rate is only one percent. The municipalitites will likely be dependent upon outside sources of financial assistance to meet necessary expenditure requirements.

The disproportionate distribution of local government tax revenues under current methods of taxation is the greatest problem in addressing population growth in the region. State and Federal aid programs help to offset this inequality, but other mechanisms need to be developed. The CB project is committed toward working with local officials to address the matter.

.7 Housing

Cathedral Bluffs-Related Housing Demand. Employment estimates and population projections presented in Tables 14.9 and 14.10 assume construction of a bachelor camp on or near Tract C-b for construction employees. The strategy would involve purchase or lease of modular units, and would involve housing for about one-half the construction work force to a maximum of 750 workers during peak construction in 1985-88.

14.3 Effects of Cathedral Bluffs Project

.7 Housing (Continued)

The discussion below comprises an analysis of housing demand generated primarily by permanent workers and related service sector population. The information in Table 14.17 represents the cumulative housing demand taking into account the proposed bachelor units, and making allowance for contractor employees and CB workers on-site as of July, 1981, who are assumed to be housed.

As can readily be noted from Table 14.17, the Cathedral Bluffs project comprises a very significant component of the Garfield and Rio Blanco County housing market during the 10-year interval examined. The period 1982-1986 is the most critical, when some 3,800 housing units will need to be brought on line. The magnitude of the construction effort becomes obvious when one considers that residential construction has averaged about 120 units per year in Rifle, and about 30 units in Meeker.

Overall, total housing demand builds very rapidly beginning in 1983, and reaches an approximate steady-state maximum of about 6,000 units in the 1989-91 time frame, inclusive of service sector housing demand.

TABLE 14.17 Housing Demand for Cathedral Bluffs-Related Population 1981-1991

Calendar Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Households	416	1128	2106	3010	4479	4812	5377	5642	5790	6143	5962
Annual Increase		712	978	904	1469	333	565	265	148	353	(181)
Cumulative New Households (Units)[a]	50[b]	785	1792	2723	4236	4579	5161	5434	5587	5950	5764
Housing Unit Location											
Rifle	33	510	1165	1770	2753	2976	3355	3532	3632	3868	3747
Meeker	13	196	448	681	1059	1145	1290	1359	1397	1488	1441
Other	4	79	179	272	424	458	516	543	558	594	576

[a] Includes 3% vacancy rate.

[b] July 1981 estimate 366 households occupied by contractor and CB employees and related service sector population.

14.3 Effects of Cathedral Bluffs Project

.7 Housing (Continued)

Planned and Potential Residential Development. An abundance of housing is potentially available in the Rifle and Meeker areas. Table 14.18 identifies a total of over 10,000 dwelling units at some stage of planning and development. A detailed inventory of present and potential residential housing is presented in Table 14.19.

The abundance of housing units which are currently planned for the Rifle and Meeker area should meet the housing needs of the developing oil shale industry and associated economic growth through at least the 1985-86 time frame. Additional housing units beyond those currently planned will be needed later in the 1980's. For the present, it appears that housing can be made available within the project area without the necessity for Cathedral Bluffs to engage directly in housing and community developement. The housing plan for the project as discussed in Section 14.5.5 includes construction of a 300-750 unit bachelor camp on or near Tract C-b. These facilities will house single status workers, and will ease the overall demand within existing communities during project construction.

.8 Aesthetic Impacts

Development associated with the proposed project will consist primarily of new housing and related access roads, and

TABLE 14.18 Summary of Planned and Potential Residential Development

	Single Family	Mobile Home	Apartment	Townhouse	Other[1]
Rifle[2]	1,206	1,739	708	218	1,690
Meeker	2,242	396	______	______	1,907
Total	3,448	2,135	708	218	3,597

Total Dwelling Units = 10,106

Source: Compiled from Table 14.19

1 Other category includes multi-family (duplex,4-plex), condominium, cluster, and patio homes.

2 Does not include Cottonwood Meadows subdivision, 250-400 units for which sketch plan lapsed.

TABLE 14.19 Planned Residential Development Within Cathedral Bluffs Project Area

evelopment	General Location	Number and Type of Units	Status
IFLE AREA			
alomino Park	N. Rifle	30 Apartment Units	Completed
Phase I		29 Single Family Lots	Completed
Phase II		15 Single Family Lots	14 completed
		70 Apartment Units	40 completed
Park Subdivision		20 Townhouses	8 units occupied 8 under construction 4 under contract to be built
Phase III		44 Single Family Lots	26 completed 10 vacant lots
Phase IV		36 Single Family Lots	Preliminary Plat approved
		36 Condominiums and Multi-family Units	
Phase V		42 Apartment Units	Preliminary Plat approved
ighlands East	E. Rifle		
Phase I		37 Single Family Lots	Completed
		10 Apartment Units	Completed
Phase II		5 Single Family Lots	1 Completed
		4 Apartment Units	0 Completed
Phase III		16 Single Family Lots	60% completed
Phase IV		36 Single Family Lots	30% completed
		64 Apartment Units	
Phase V		60 Single Family Lots	10% completed
Phase VI		77 Single Family Lots (Cluster Homes)	Final plat approved
Phase VII		62 Single Family Lots	First reading approved

TABLE 14.19 (Continued)

evelopment	General Location	Number and Type of Units	Status
ifle Area (Continued)			
rabian Heights Phase I & II	N.E. Rifle	27 Single Family Lots	16 completed
Phase III		49 Single Family Lots 40 Multi-family Units	Resubmitted sketch plan
ings Crown Mobile ome Subdivision	N.W. Rifle		
Phase I		103 Mobile Home Spaces	Completed
Phase II		147 Mobile Home Spaces	Planned for 1981
hadow Ridge	W. Rifle	10 Single Family Lots	4 completed
Phase I		12 Cluster Homes 34 Townhouses	20 completed
Phase II		20 Condominiums 14-15 Duplexes 11 Single Family Lots	8 completed (single family)
imrock	N. Rifle		
Phase I		288 Condominiums 240 Apartments 223 Single Family Lots 100 Multi-family (Duplexes and Four-Plexes)	Final plat approved
Phase II		144 Apartments 192 Condominiums 187 Single Family Units	Sketch plan approved
Phase III		580 Mobile Homes 456 Apartments 272 Condominiums	Forwarded to City Council by Planning Commission without recommendation. Will go to Council upon completion of water and sewer study for northern end of town by Arix.

TABLE 14.19 (Continued)

evelopment	General Location	Number and Type of Units	Status
ifle Area (Continued)			
esa View Estates	S.W. Rifle		
Phase I		34 Single Family	95% completed
Phase II		10 Single Family Lots	Preliminary Plat approved
nollridge P.U.D.	N.W. Rifle	156 Condominiums 50 Townhouses	Final plat approved Approval Dec. 7, 1980
orth Meadows	N. Rifle	250 Multi-family	Inactive, will probabl be resubmitted
ifle Heights	E. Rifle	100 Single Family	Sketch plan lapsed
ahogany Addition	S. Rifle	Commercial and Residential 10 Multi-family Units	Motel and restaurant under construction 5 multi-family units built
Cedar Townhouses		7 Units in Mahogany Addition	Condominiumization (under moratorium)
rapper Hollow P.U.D.	W. Rifle	28 Condominium Units	0 completed
arnett P.U.D.	W. Rifle	16 Condominium Units	4 units completed
armack Mobile ome Subdivision	N. Rifle		
Phase I		164 Mobile Home Lots	Preliminary plat approved
Phase II		420 Multi-family Units	Sketch plat approved
reek Meadows	N. Rifle	14 Commercial Lots 36 Condominiums	Final plat Approved Dec. 17, 1980 Under construction
airview Townhomes		20 Townhouses	Final plat approved
Jackson Heights (Senior Citizen and subsidized housing)	W. Rifle	8 Single Family Lots 25 Condominiums 16 Cluster Houses	Final plat approval October 1, 1980

TABLE 14.19 (Continued)

evelopment	General Location	Number and Type of Units	Status
ifle Area (Continued)			
unset Patio Homes			
Phase I		6 Patio Homes	Near completion Approved May 21, 1980
Phase II		6 Patio Homes	Completed Approved Jan. 21, 1981
reekside			
Phases I and II		31 Townhouses	Final plat approved Approval Jan. 7, 1981
Phase III		9 Townhouses	Preliminary plat Approval
ilver Cliff Heights		4 Condominiums	Final plat approved Approval Jan. 7, 1981
lorizons West		55 Single Family Lots	Final plat approved February 20, 1980
'Brien Condominiums		6 Condominium Units	Sketch plan approval
ifle View		24 Condominiums	Has not yet gone to Planning Commission
hetland Acres		56 Single Family Lots 13 Duplexes 48 Townhouses	Has not yet gone to Planning Commission
calzo Ranch		60 Condominiums	Has not had sketch plan approval yet
eerfield P.U.D.		169 Mobile Home Lots 156 Mobile Home/Modular lots 88 Apartment/Condominium Units	Sketch plan approval
ioneer Estates (S. of Shadow Ridge)		18 Single Family Lots	11 built
ourt Building		10 Apartments	Inactive
restview P.U.D.		1 Single Family Home 5 Condominiums	Inactive
alley View Townhouses		6 Townhouses	Final plat approval May 21, 1980

TABLE 14.19 (Continued)

Development	General Location	Number and Type of Units	Status
MEEKER			
Sanderson Hills	N. Meeker	275 Single Family 75 Milti-Family Units Townhouses and Aprtments (Number Undecided)	20 completed 10 completed 0 completed
Sage Hils	N. Meeker	104 Single Family Lots	Approved but not yet under construction
Meeker Terrace	N.E. Meeker	1,784 Single Family Lots 1,810 Milti-Family Units 396 Mobile Home Spaces	Preliminary planning
Pinyon Park	N.W. Meeker	21 Single Family Lots	10 completed
Foothills	N.W. Meeker	15 Single Family Lots 18 Multi-Family Units (Duplexes)	10 completed 4 completed
Sage Park	N.W. Meeker	15 Single Family Lots 4 Multi-Family Units (Duplexes)	5 completed 0 completed
Purple Sage	N. 10 miles Strawberry Creek	3 Single Family Lots	
Mesa View II	S. of Meeker 1 mile	13 Single Family Lots	
River Bend	E. of Meeker Across from Warner Points	4 Single Family Lots	
El Escondido	N. of Meeker (Possibility of annexation)	8 Single Family Lots	

14.3 Effects of Cathedral Bluffs Project

.8 Aesthetic Impacts (Continued)

improvements to existing roadways. Most housing development will occur within existing communities and will conform to established development plans. Temporary construction worker housing will be placed on or near the tract and will be integrated within the industrial complex. Visual impacts will be minimal. The overall impact on regional air quality will be well within permissible limits.

Population densities will be increased in the communities of the region, but not to the point of overcrowding. To date, population densities in Rifle and Meeker have been very low, which has resulted in a high cost per capita for delivery of local government services. The muncipalities are now making an effort to reduce these per capita costs through policies for infilling and higher density housing development.

.9 Lifestyle and Cultural Resources

Projected population growth will cause changes in the rural lifestyle of the region. People with different attitudes and preferences will migrate to the area. Agriculture and tourism will be replaced by energy resource development as the dominant local economic sector. Recreation areas will become more crowded, but a greater diversity in social, cultural, and recreation experiences will be available for the population.

14.0 SOCIOECONOMICS

14.4 Mitigation Measures

There are several specific measures available to local government agencies to avoid or reduce adverse effects of rapid population growth. Some of these measures involve increased revenues either through local sources or State and Federal government sources. Mitigation can also be achieved through industry initiatives, such as policies to hire and train local employees and to provide transportation and housing facilities.

.1 Additional Tax Resources

As discussed in the previous section, local government entities will benefit from increased local taxes, but to varying degrees. The projected tax revenue increases displayed in Table 14.16 are based on current tax rates. Current tax rates will likely be adjusted over time, as the tax base of each entity changes.

Some entities, such as the RE-1 School District and Rio Blanco County may be able to reduce taxes overall because of large increases in tax rate, while Meeker and Rifle may have to increase taxes in order to keep pace with the costs of growth. Some of the inequity in tax base distribution might be overcome through cost sharing among local governments, such as a use of county revenues to finance municipal projects. Another mechanism available for more equitably distributing the tax base is the use of special service districts.

14.0 SOCIOECONOMICS

14.4 Mitigation Measures

.2 State and Federal Assistance Programs

The Colorado Oil Shale Trust Fund (OSTF) is a primary source of financial assistance to local governments in the project area for construction of facilities and provision of services. The OSTF had an original sum of $75 million, which was the Colorado share of lease-hold payments for Tracts C-a and C-b. The OSTF has been used extensively since 1975, and is primarily responsible for the excess capacity which now exists in local water, sewer, school, and health care facilities.

Remaining funds in the amount of $47 million have been appropriated by the 1981 general assembly, and are awaiting distribution to the respective counties. Garfield County's available share includes some $22.3 million. Rio Blanco county will receive $16.7 million, with the remainder distributed to Mesa ($6.5 million), and Moffat Counties ($2.2 million). The additional funds will go toward capital facilities construction to support expected population increases within the four county area.

In addition to the OSTF, Colorado has another financial assistance program available to local governments affected by energy development. That program is the Energy Impact Assistance Program, which contains a portion of the revenues paid to the State in mineral severance taxes and Federal mineral porduction royalty payments. Some $7 million each year is now available to local governments in the form of grants through the program.

14.4 Mitigation Measures

.2 State and Federal Assistance Programs (Continued)

Federal programs through Farmers Home Administration, HUD, EDA, IPA, DOE, and DOT have been available in the past to local governments in the form of financial assistance for various purposes. These sources appear very doubtful for the future, in the absence of significant federal commitment to the secondary effects of domestic energy resource development.

14.5 Corporate Assistance

.1 General

The Cathedral Bluffs Project has participated in managing socioeconomic impacts from the very beginning of tract development. Activities in which the project has been directly involved are discussed in the following sections.

.2 Impact Mitigation Task Forces

Formed in late 1977, the Mitigation Task Forces in Rio Blanco County and Western Garfield County remain important mechanisms for managing socioeconomic impacts. In fact, the Western Garfield County task force was recently expanded to include the entire county. In Mesa County also, a task force has been formed with some of the same objectives.

.3 Planning Assistance

The CB Project provides the assistance of a professional planning consultant to local public agencies and groups on an as-needed

14.5 Corporate Assistance

.3 Planning Assistance (Continued)

basis. This professional assistance has been called upon for projects including a recreation master plan, low-income housing project, planning for hospital expansion, financing for expanded library and senior citizen programs, and numerous grant proposals.

.4 Transportation

Transportation issues and ensuing decisions are important determinants of overall impact.

One of the major initiatives pursued by CB management to deal with transportation problems was provision of a bus service for employees between Meeker and Rifle and the tract. This service was initiated early in April of 1978 and consists of six 47-passenger coaches operating seven days per week. Pickup points and parking are provided for CB employees, contractors, and contractor's employees.

The buses save fuel, because of the number of passengers carried, aid in reducing road kills of livestock and wildlife, eliminate excess motor traffic on the highways (thereby lessening pollution), and provide a comfortable ride and added safety for the employee. Twenty-five to forty of these buses will be in operation as the work force expands to commercialization. The CB project also has assisted Rio Blanco County and the State Highway Department with

14.0 SOCIOECONOMICS

14.5 Corporate Assistance

.4 Transportation (Continued)

installation of magnetic loop road counters to count vehicle traffic on Piceance Creek Road.

Other transporation matters have been investigated such as means to minimize road wildlife kills and automobile accidents. Studies are in progress on the use of rail and pipeline services for product shipping and other materials.

.5 Housing

An essential element related to the CB Project is the provision of housing. In any rapid growth area housing demand is high. To deal with this problem, the CB Project has taken several steps.

A 40-unit apartment complex has been established in Rifle and a 48-unit complex provided in Meeker. The units have hot water heat, two bedrooms and are furnished with refrigerator, dishwasher and stove. The grounds are completely landscaped, and have paved parking area. A two-year lease agreement was signed with the builder to facilitate construction and permanent financing.

In addition, a mobile home park was prepared in Rifle. The park has 103 spaces expandable to 300 spaces and can accommodate single and double-wide mobile homes as well as campers and recreational vehicles. Underground utilities, laundry facilities

14.5 Corporate Assistance

.5 Housing (Continued)

and recreational areas are provided. This property is owned by Cathedral Bluffs.

Prior to this activity, a detailed housing analysis was prepared for CB management to examine short and long-range housing plans. As a part of the housing program, CB personnel have worked closely with the cities of Meeker and Rifle to assure that any housing developed under their auspices or sponsorship conforms with local zoning regulations and housing standards. This association will be continued.

Additional efforts have involved assistance by staff personnel and consultants in obtaining housing for the elderly and in dealing with many of the planning issues related to housing demand and supply.

The housing plan for construction and permanent employment pursuant to this Detailed Development Plan revision is formulated around the projected housing demand from Table 14.17, with some modifications and assumptions as follows:

- Bachelor units will be constructed on or near Tract C-b (1983 = 300 units; 1984 = 500 units; 1985-88 = 750 units; 1989 = 350 units).
- Housing type will reflect a mix of 60 percent single family; 25 percent mobile home; and 15 percent

14.5 Corporate Assistance

.5 Housing (Continued)

multifamily comprised of apartments, townhouses, duplex and 4-plex, condominium, and cluster homes.

- Ten percent of total CB-related housing demand will be met in areas other than the communities of Rifle and Meeker and will require no direct or indirect CB assistance.
- Housing for induced employment is not the responsibility of CB, but a commitment to assist in planning for and, indirectly, in the provision of 50 percent of the estimated housing needs for the induced sector will help to provide for well balanced community development.

An estimate of cumulative housing demand for contractor and CB employees, and the 50 percent "share" of induced employee housing is presented in Table 14.20. The data reflect a three percent vacancy fraction with 65 percent of the permanent housing stock allocated to Rifle, and 25 percent to Meeker.

The trends in demand grow with time uniformly, except for a slight decrease after 1990. Despite the relatively large number of units required, and except for bachelor quarter construction, the program at no time suggests the need for overbuilding of temporary facilities, and subsequent removal or conversion of these to permanent dwelling units.

14.5 Corporate Assistance

.5 Housing (Continued)

Further refinement of the techniques and multipliers utilized to develop information as shown in Table 14.20 is needed. However, for planning purposes, the data can be used in conjunction with an ongoing monitoring program to examine land requirements, and to make short and medium-term plans for housing development.

.6 Health and Human Services

A constant concern of the Project is the health and safety of its employees, their families, and the residents of the local communities. Considerable effort has gone into programs dealing with health and human services both for employees and communities.

The CB Project has provided information necessary for planning health services in both Garfield and Rio Blanco Counties. Additionally, direct planning assistance has been provided the Grand River Hospital District, Clagett Hospital and the E. Dene Moore Nursing Home. A planning guide and plan is being developed for the district.

A study was made of the social impacts experienced to date and what might be expected in the future for the oil shale area. The report was prepared in conjunction with a citizen's group from the Rifle area. Included are recommendations for forming a human services task force, a guide to available services in the

TABLE 14.20 Cumulative Housing Demand for Cathedral Bluffs and Induced Employment[1] 1981-1991

HOUSING TYPE

Calendar Year	Bachelor Units	Mobile Home		Multi-Family		Single Family		Total
		Rifle	Meeker	Rifle	Meeker	Rifle	Meeker	
1981	-	8	3	5	2	20	8	46
1982	-	102	39	61	23	244	94	563
1983	300	223	86	134	51	535	206	1535
1984	500	337	130	202	78	808	311	2366
1985	750	563	217	338	130	1350	520	3868
1986	750	610	235	366	141	1463	563	4128
1987	750	675	260	405	156	1621	623	4490
1988	750	698	268	419	161	1674	644	4614
1989	350	719	277	431	166	1724	664	4331
1990	-	758	292	455	175	1919	700	4199
1991	-	732	282	440	169	1759	676	4058

1 Induced employment = 50% of total CB-related indirect employment.

14.0 SOCIOECONOMICS

14.5 Corporate Assistance

.6 Health and Human Services (Continued)

area, an assessment of social issues in high growth communities and an explanation of problems which might be generated.

.7 Employment

The CB Project advertises locally through the newspapers and Job Services of Colorado offices to fill positions at the C-b Tract. First consideration is given to local persons with requisite skills.

Personnel with the CB Project work closely with CETA Programs and others to provide a full range of opportunities where applicable skills are available.

.8 Employee Education

Educational programs are conducted for both employees and community members who may someday seek employment with the Project.

In addition to the training programs discussed in the following section, tuition is paid for courses leading toward a degree or providing skills relevant to the employees' job.

.9 Training Program

The CB Project has a full-time training staff and plans to expand that group as called for by employment requirements. Because of the desire to hire locally and the need to develop a

14.5 Corporate Assistance

.9 Training Program (Continued)

large work force, training will play a critical role in the future of the project. Training will be provided in all phases of project operations from safety and basic job skills to managerial preparation. The CB Project also has assisted Colorado Mountain College and Mesa College in the establishment of vocational courses in the area of diesel mechanics, mine electricity, and other subjects relevant to the mining industry.

14.6 Project Supported Mitigation Program

A continued active role in the mitigation of socioeconomic impacts is anticipated by the project. This mitigation program will consist of two parts; the first being activities to support and strengthen the role of local governments, and the second being direct actions by the project.

.1 Technical Support and Assistance

To assist local government, Cathedral Bluffs will continue to provide current information concerning all aspects of the project. This information will include the full range of work force data and information as is now made available through the project socioeconomic monitoring reports.

Technical assistance for local government planning and development activities will also continue. Cathedral Bluffs has contributed specilized expertise when necessary to local

14.6 Project Supported Mitigation Program

.1 Technical Support and Assistance (Continued)

government agencies to help them solve specific problems. This type of assistance is most valuable in rural areas where local government staffs are small and without experience in dealing with many of the problems of rapid growth. Cathedral Bluffs realizes that this type of skilled technical assistance can avoid costly mistakes or delays in public sector projects; projects which are important to the living environment of its employees.

.2 Cathedral Bluffs Programs

Direct activities to be undertaken by the CB Project to alleviate socioeconomic effects will include comprehensive programs for work recruitment, training, housing and transportation. The recruitment and training programs will be structured to hire as many local residents as possible to reduce the influx of persons to the area. Given the short supply of labor available locally, however, CB realizes that much of the labor will have to be brought in from other areas. The recruitment program will include screening techniques to identify those persons compatible with the working environment, thus reducing the potential for turnover.

Training. A comprehensive training program will be available to all employees which will allow local residents a better entry

14.6 Project Supported Mitigation Program

.2 Cathedral Bluffs Programs (Continued)

to employment opportunities with the Project. The training program will also enable some construction workers to make the transition to permanent employees, reducing the overall demand for labor.

Transportation. The busing program which is now in operation will be expanded as the work force expands. Busing all project employees from their community of residence to the CB site will greatly reduce the traffic load on local roadways; reducing maintenance costs as well as potential danger to humans and wildlife.

Housing. The CB housing program will feature the provision of initial basic housing and services for project employees. The housing needs of the local service work force generated by the CB Project will be addressed, including community and region-wide assistance in planning for the necessary housing and services.

In addition to bachelor camp construction, Cathedral Bluffs plans to pursue a range of programs to ensure the availability of developed building spaces (single-family lots and mobile home spaces) and finished units ready for occupancy. These programs are not well defined at this time, but will include such elements as master leases on multi-family units, builder guarantees, and

14.6 Project Supported Mitigation Program

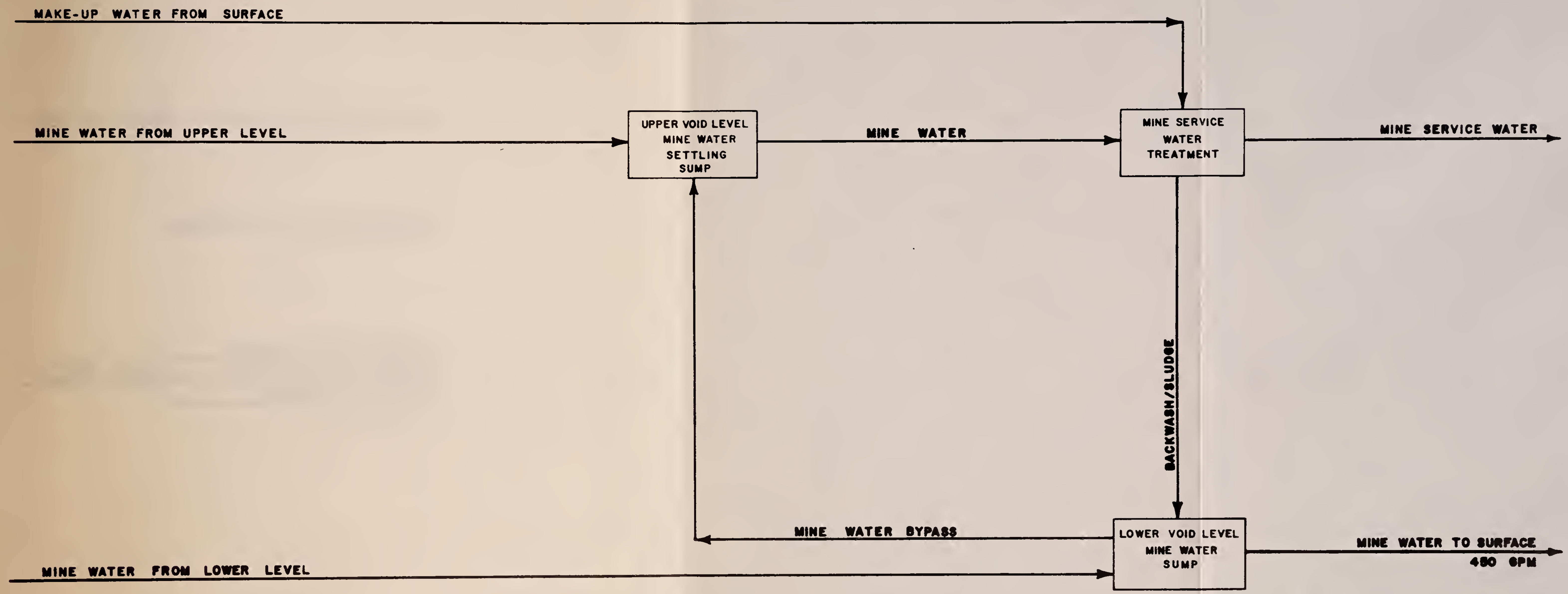
.2 Cathedral Bluffs Programs (Continued)

CB ownership and rental of mobile homes and mobile home lots. Employee housing assistance policies and procedures are being developed. These are viewed as proprietary and are not discussed except to state that measures are planned in order to overcome the high costs for employees to enter the housing stream, and to provide quality housing at terms within the reach of all employees.

No direct financial assistance is planned in the area of housing for induced employees. These individuals will benefit indirectly through CB efforts to make available the housing stock identified in Table 14.20.

14.7 Public Sector Financial Assistance

Overall, the most serious adverse impact to local communities will be the lag in public revenues relative to the public costs of expanded services in those entities which will not benefit directly from the new industrial tax base. This revenue lag is created somewhat by the economic system, and somewhat by the methods of ad valorem tax collection. Property tax revenues collected on new construction generally lag one to two years behind the time construction is completed. The opening of new commercial establishments, which create the base for retail sales tax revenues, also lag behind employment in the industrial sector.



NO	BY	DESCRIPTION	J.E.	S.E.
A		FLOW QUANTITIES UPDATED		

REVISIONS

CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO

CONFIDENTIAL MATERIAL

PRELIMINARY

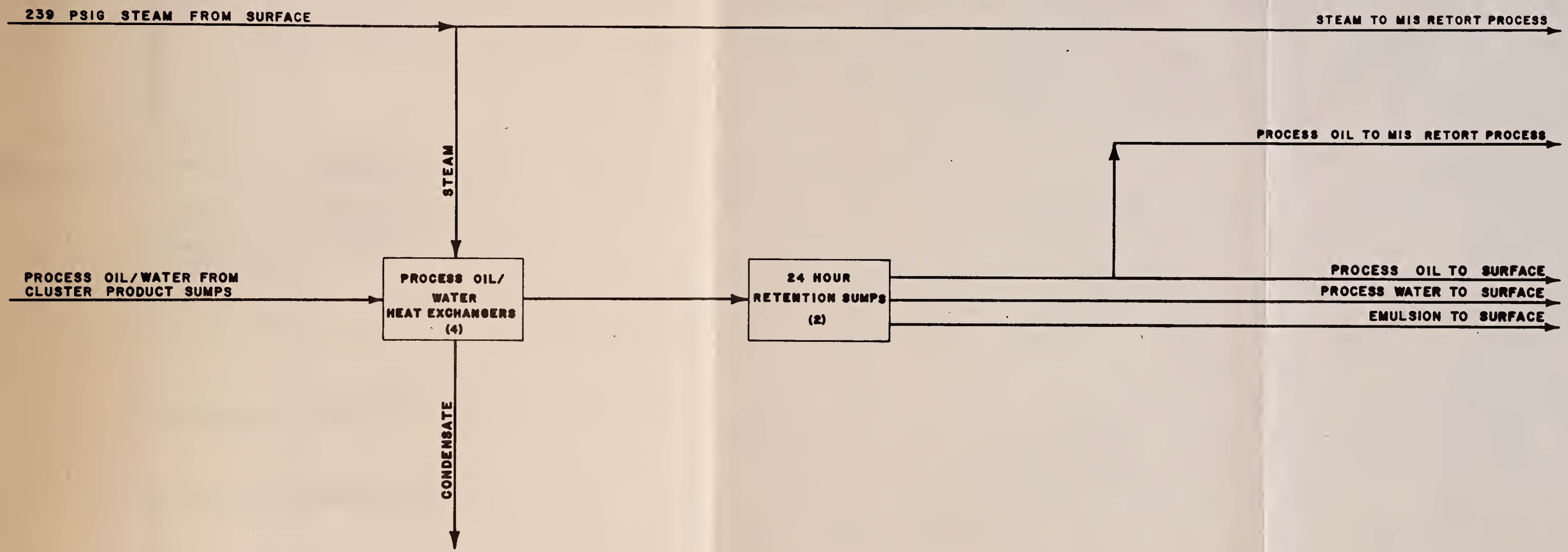
ISSUE NO. 2 DATE PRINTED 9/23/80

BLOCK FLOW DIAGRAM
MINE WATER SYSTEM

DR BV
CH
J. E.
SCALE
SECT.
CODE
CHF. S. E.
APP'D
CONTRACT NO. M-7545

Dravo

DRAWING NO. EF-102
REV. A



NO	BY	DESCRIPTION	J.E	S.E

REVISIONS

CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO

CONFIDENTIAL MATERIAL

PRELIMINARY NOT APPROVED FOR CONSTRUCTION

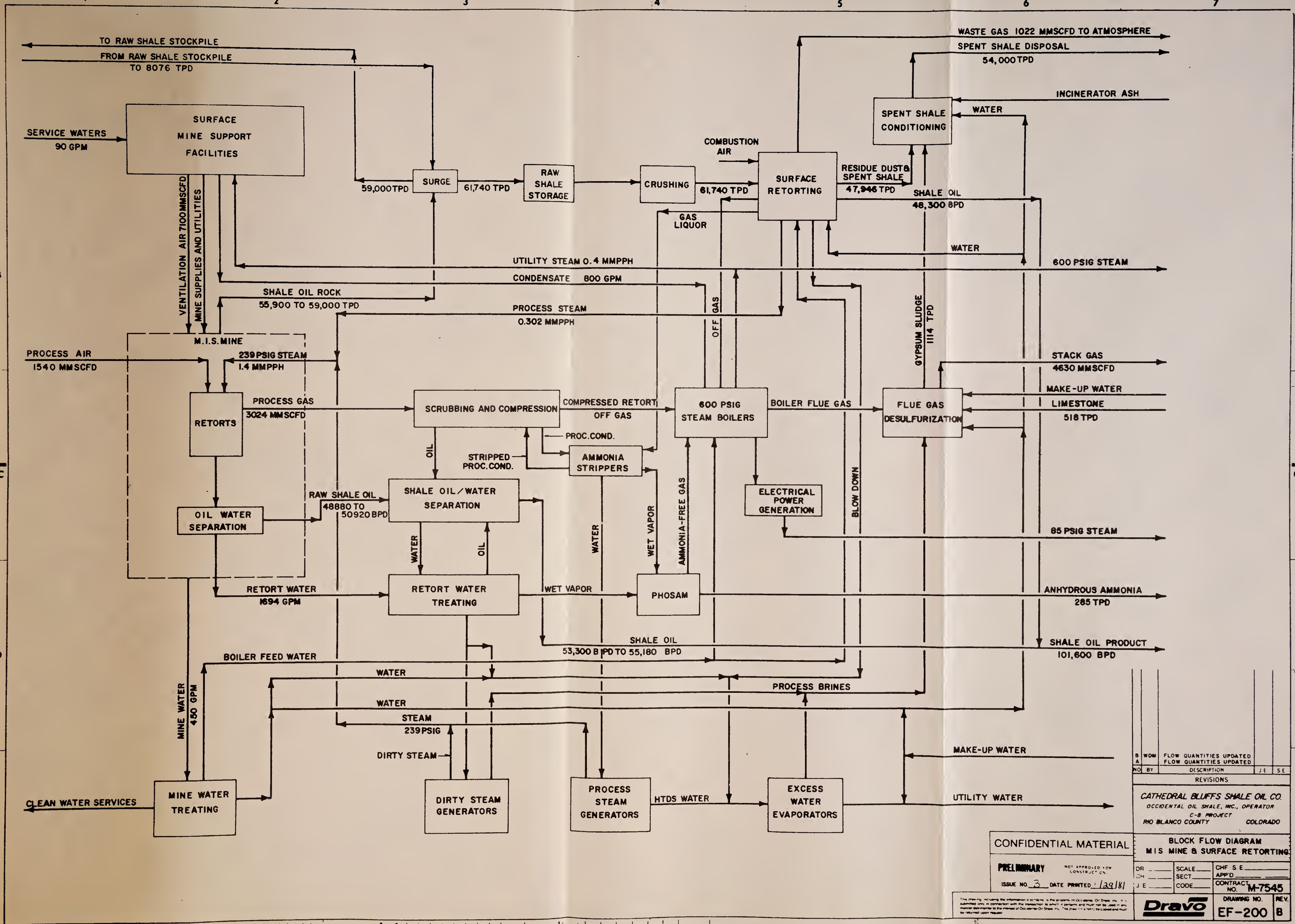
ISSUE NO. 2 DATE PRINTED 9/23/80

BLOCK FLOW DIAGRAM
PROCESS OIL / WATER

DR B.V. SCALE ___ CHF. S. E. ___
CH ___ SECT. ___ APP'D ___
J. E. ___ CODE ___ CONTRACT NO. M-7545

Dravo

DRAWING NO. EF-103 REV.



NO	BY	DESCRIPTION
B	WDM	FLOW QUANTITIES UPDATED
A		FLOW QUANTITIES UPDATED

REVISIONS

CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO

CONFIDENTIAL MATERIAL

PRELIMINARY — NOT APPROVED FOR CONSTRUCTION

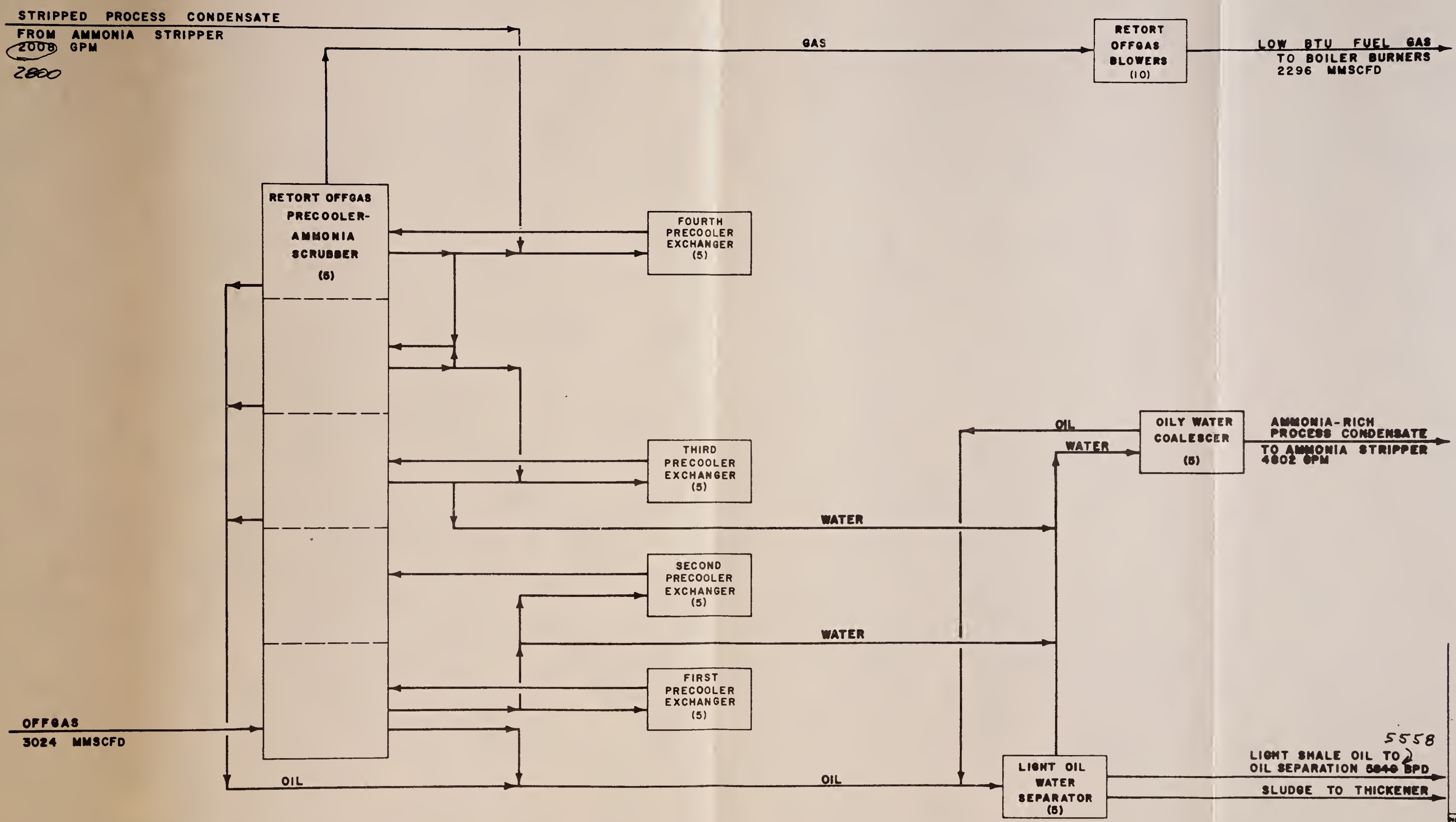
ISSUE NO. 3 DATE PRINTED 1/29/81

BLOCK FLOW DIAGRAM
MIS MINE & SURFACE RETORTING

CONTRACT NO. M-7545

Dravo

DRAWING NO. EF-200 REV. B



NO	BY	DESCRIPTION	J.E.	S.E.

REVISIONS

CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO

CONFIDENTIAL MATERIAL

BLOCK FLOW DIAGRAM
OFFGAS SCRUBBING & COMPRESSION

PRELIMINARY — NOT APPROVED FOR CONSTRUCTION

ISSUE NO. 2 DATE PRINTED 9/23/80

DR B.V. CH ____ J.E. ____
SCALE ____ SECT. ____ CODE ____
CHF. S.E. ____ APP'D ____
CONTRACT NO. M-7545

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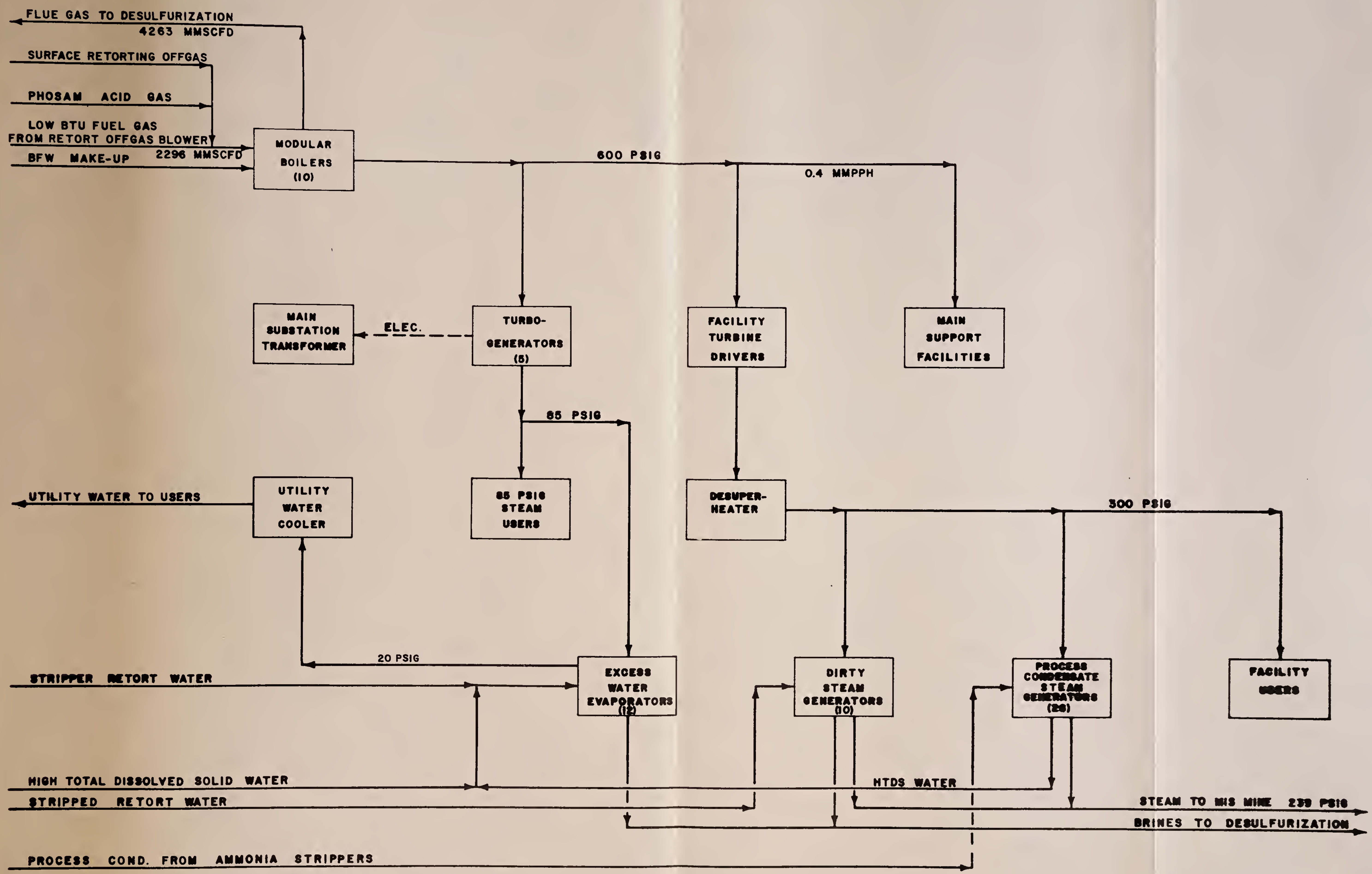
Dravo

DRAWING NO. EF-201 REV.



NOT SHOWN: CONDENSATE RETURNS TO BOILER FEEDWATER

NO	BY	DESCRIPTION	J.E.	S.E.
REVISIONS				

CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO

CONFIDENTIAL MATERIAL

PRELIMINARY — NOT APPROVED FOR CONSTRUCTION

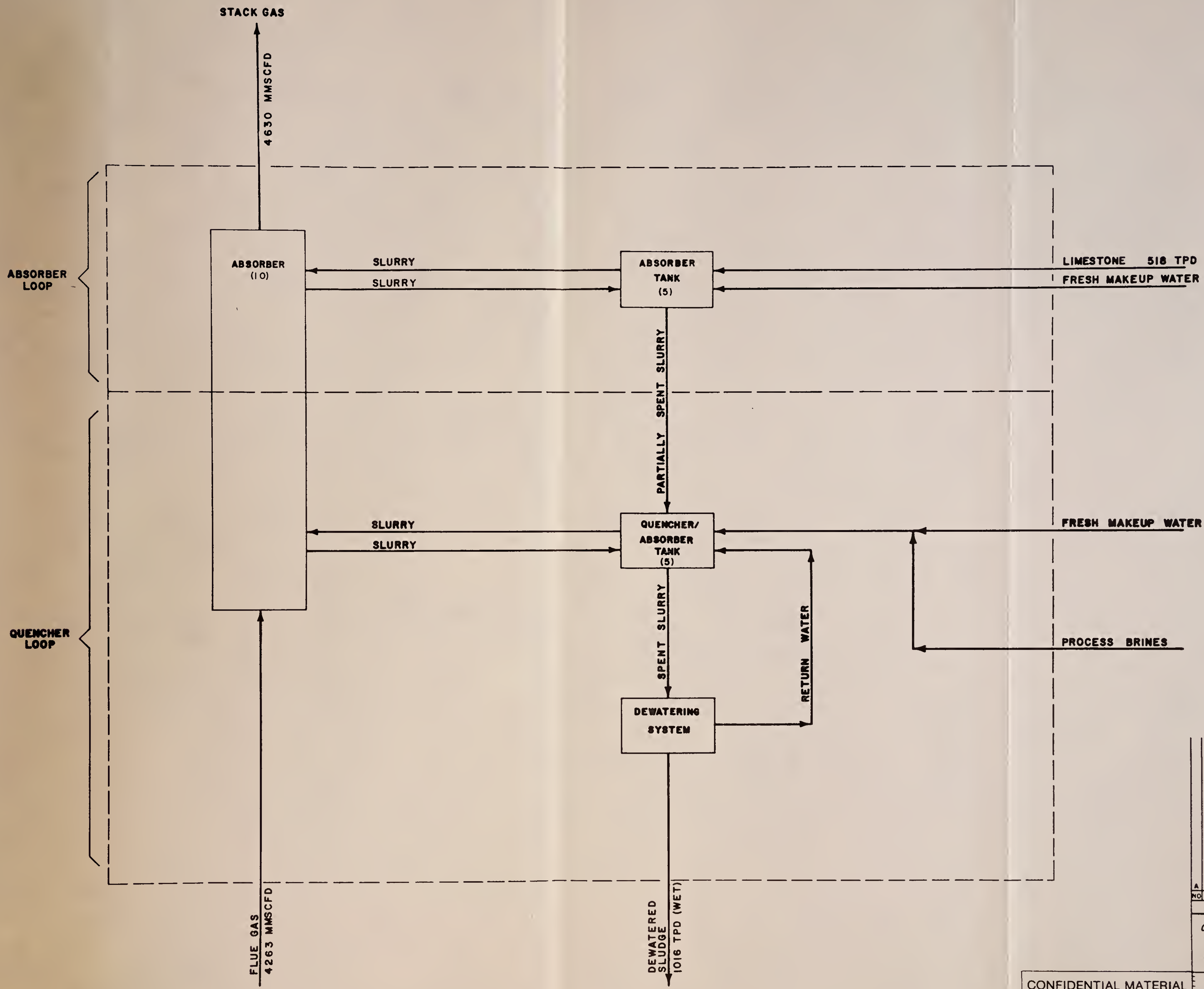
ISSUE NO. 2 DATE PRINTED 9/23/80

BLOCK FLOW DIAGRAM
STEAM AND POWER GENERATION

DR B.V. CH ___ J.E. ___
SCALE ___ SECT ___ CODE ___
CHF. S.E. ___ APP'D ___
CONTRACT NO. M-7545

Dravo

DRAWING NO. EF-202 REV.



NO	BY	DESCRIPTION	J.E.	S.E.
A		FLOW QUANTITIES UPDATED		

REVISIONS

CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO

CONFIDENTIAL MATERIAL

PRELIMINARY

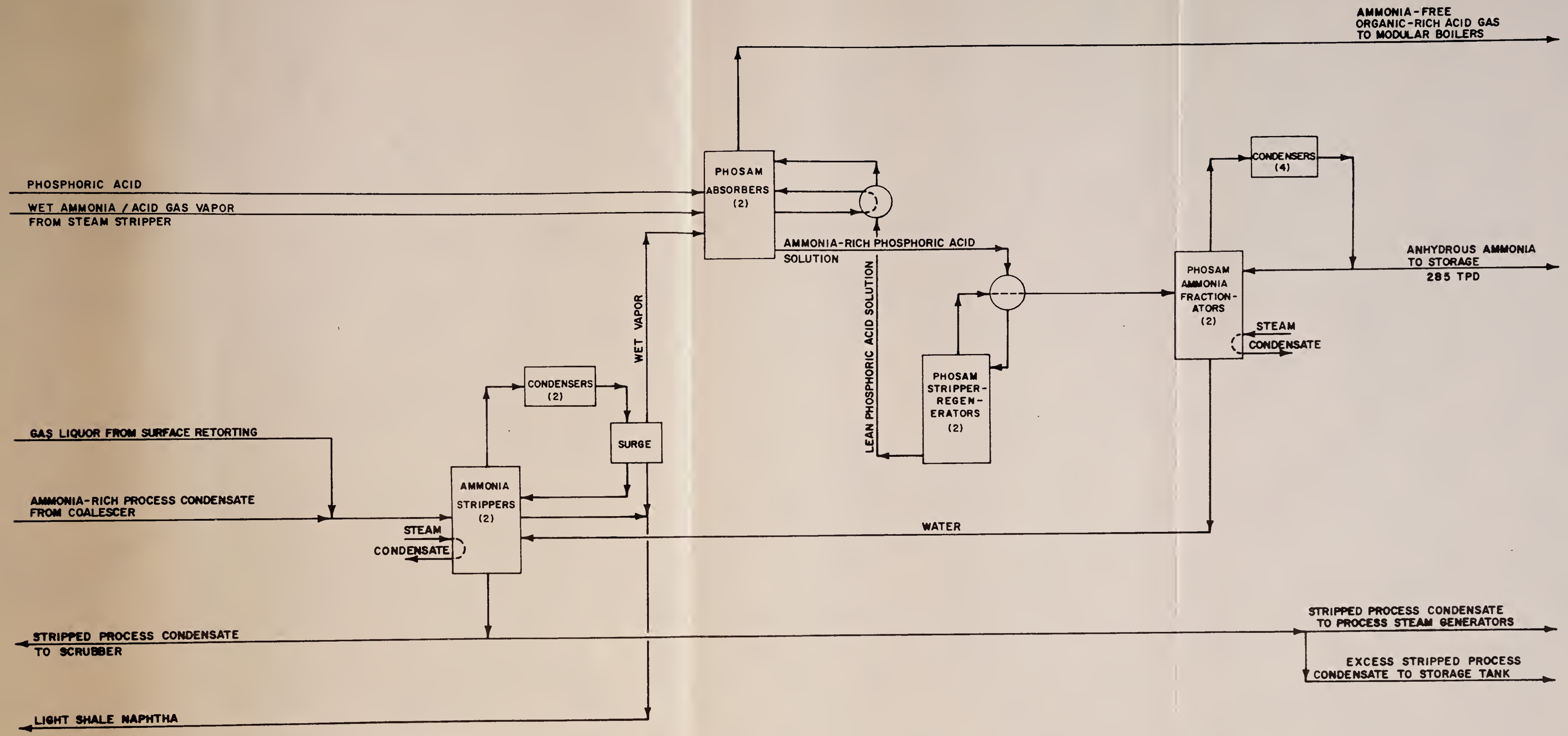
ISSUE NO. 2 DATE PRINTED 9/23/80

BLOCK FLOW DIAGRAM FLUE GAS DESULFURIZATION

DR B.V. CH J.E.
SCALE SECT. CODE
CHF. S.E. APP'D
CONTRACT NO. M-7545

Dravo

DRAWING NO. EF-203 REV. A



NO	BY	DESCRIPTION	J E	S E
A	WDM	ADDED GAS LIQUOR LINE		

REVISIONS

CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO

CONFIDENTIAL MATERIAL

PRELIMINARY

ISSUE NO 1 DATE PRINTED 1/29/81

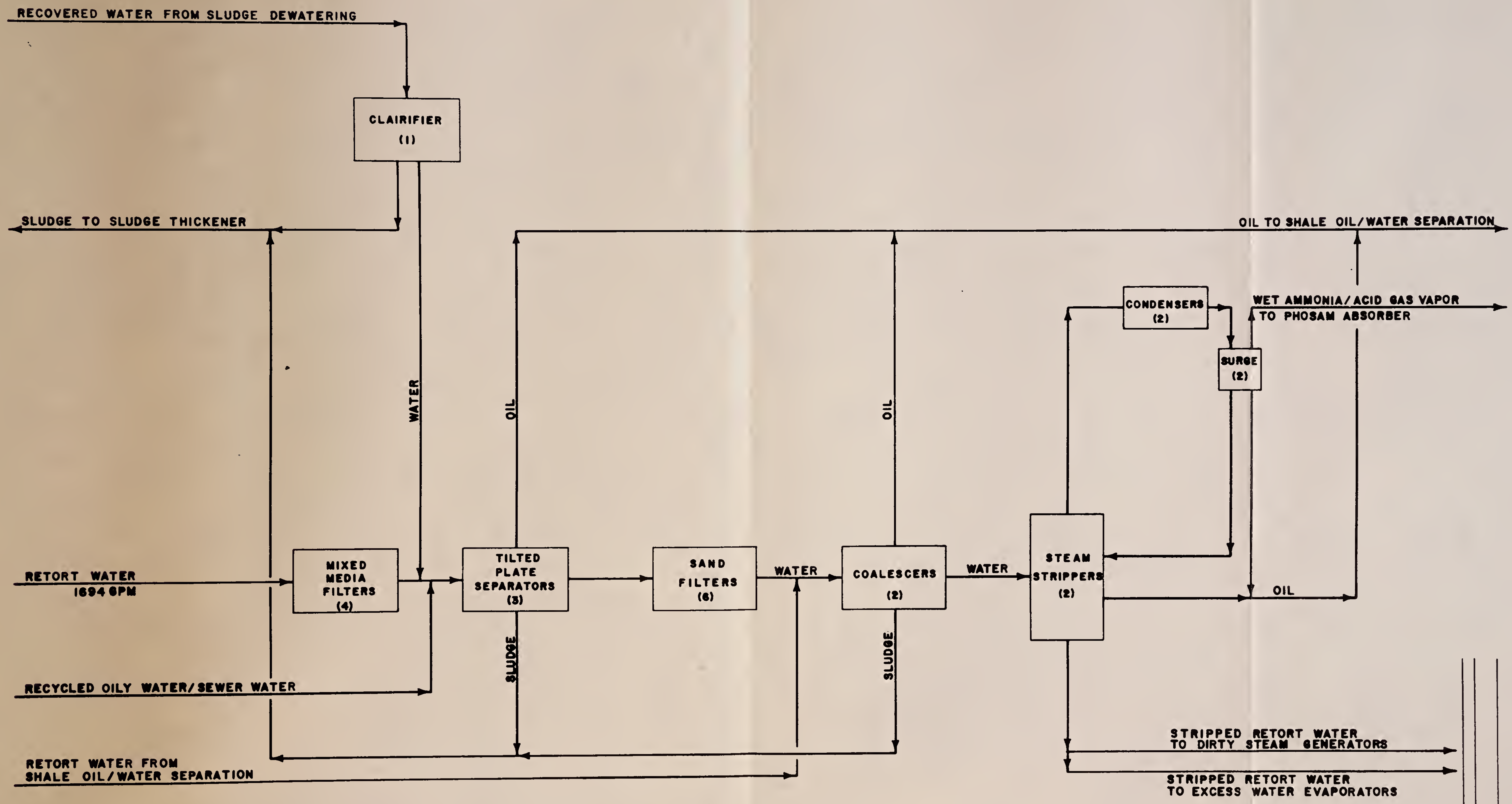
BLOCK FLOW DIAGRAM
PROCESS CONDENSATE
TREATING AND PHOSAM

DR. B V
CH.
J E
SCALE
SECT.
CODE
CHF. S. E
APP'D
CONTRACT NO. M-7545

Dravo

DRAWING NO. EF-204

REV. A



NO	BY	DESCRIPTION	J.E.	S.E.

REVISIONS

CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY *COLORADO*

CONFIDENTIAL MATERIAL

PRELIMINARY NOT APPROVED FOR CONSTRUCTION

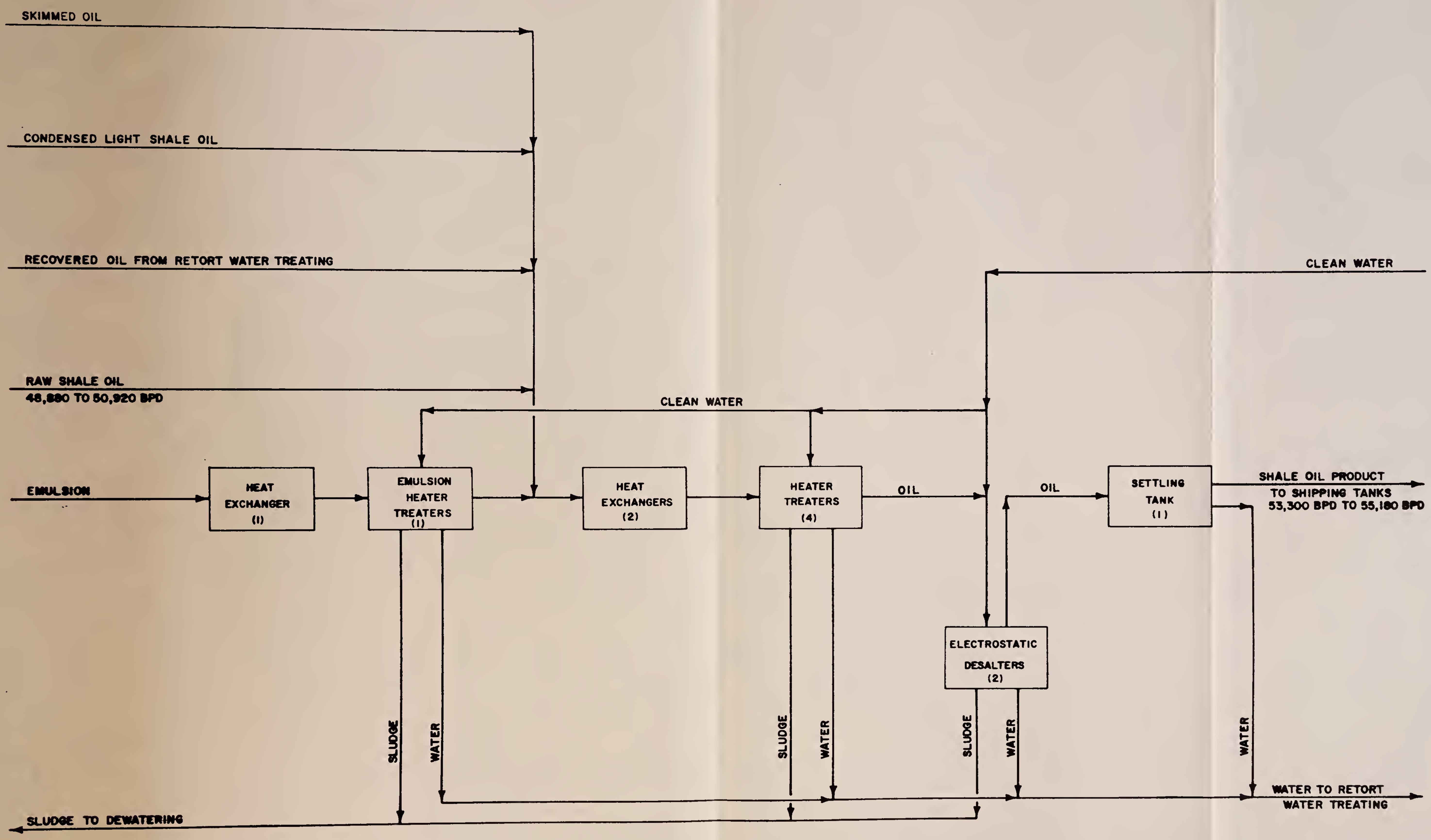
ISSUE NO. 2 DATE PRINTED 9/23/80

BLOCK FLOW DIAGRAM
RETORT WATER TREATING

DR B.V. SCALE ___ CHF. S.E. ___
CH ___ SECT ___ APP'D ___
J.E. ___ CODE ___ CONTRACT NO. M-7545

Dravo

DRAWING NO. EF-205 REV.



NO	BY	DESCRIPTION	J E	S E
B	WDM	FLOW QUANTITIES UPDATED		
A		FLOW QUANTITIES UPDATED		

REVISIONS

CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO

CONFIDENTIAL MATERIAL

PRELIMINARY

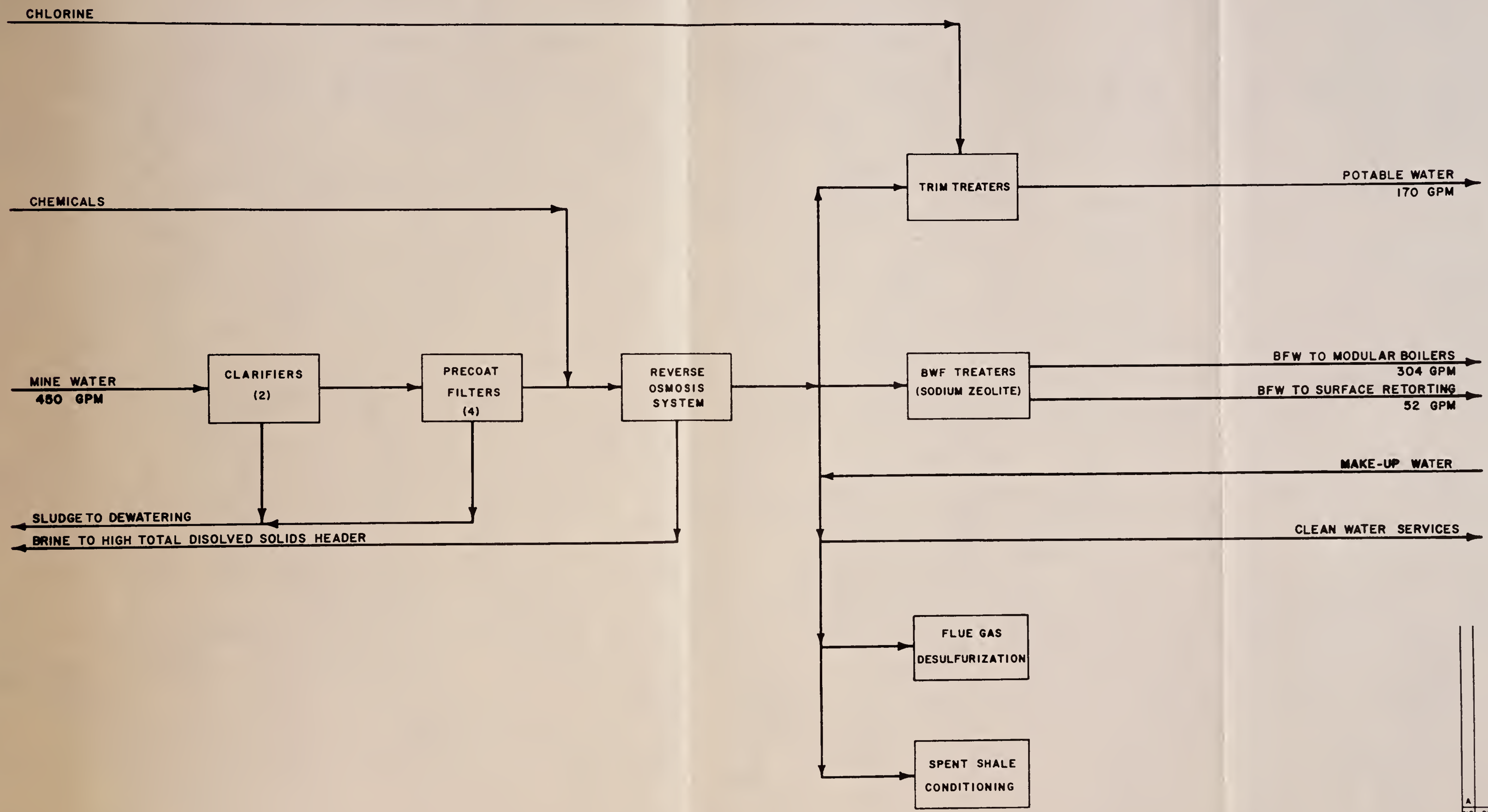
ISSUE NO. 3 DATE PRINTED 1/24/81

BLOCK FLOW DIAGRAM
SHALE OIL / WATER SEPARATION

DR B.V. SCALE ____ CHF S.E. ____
CH ____ SECT ____ APP'D ____
J.E. ____ CODE ____ CONTRACT NO M-7545

Dravo

DRAWING NO. EF-206 REV. B



NO	BY	DESCRIPTION	J.E.	S.E.
A		FLOW QUANTITIES UPDATED		

REVISIONS

CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO

CONFIDENTIAL MATERIAL

PRELIMINARY

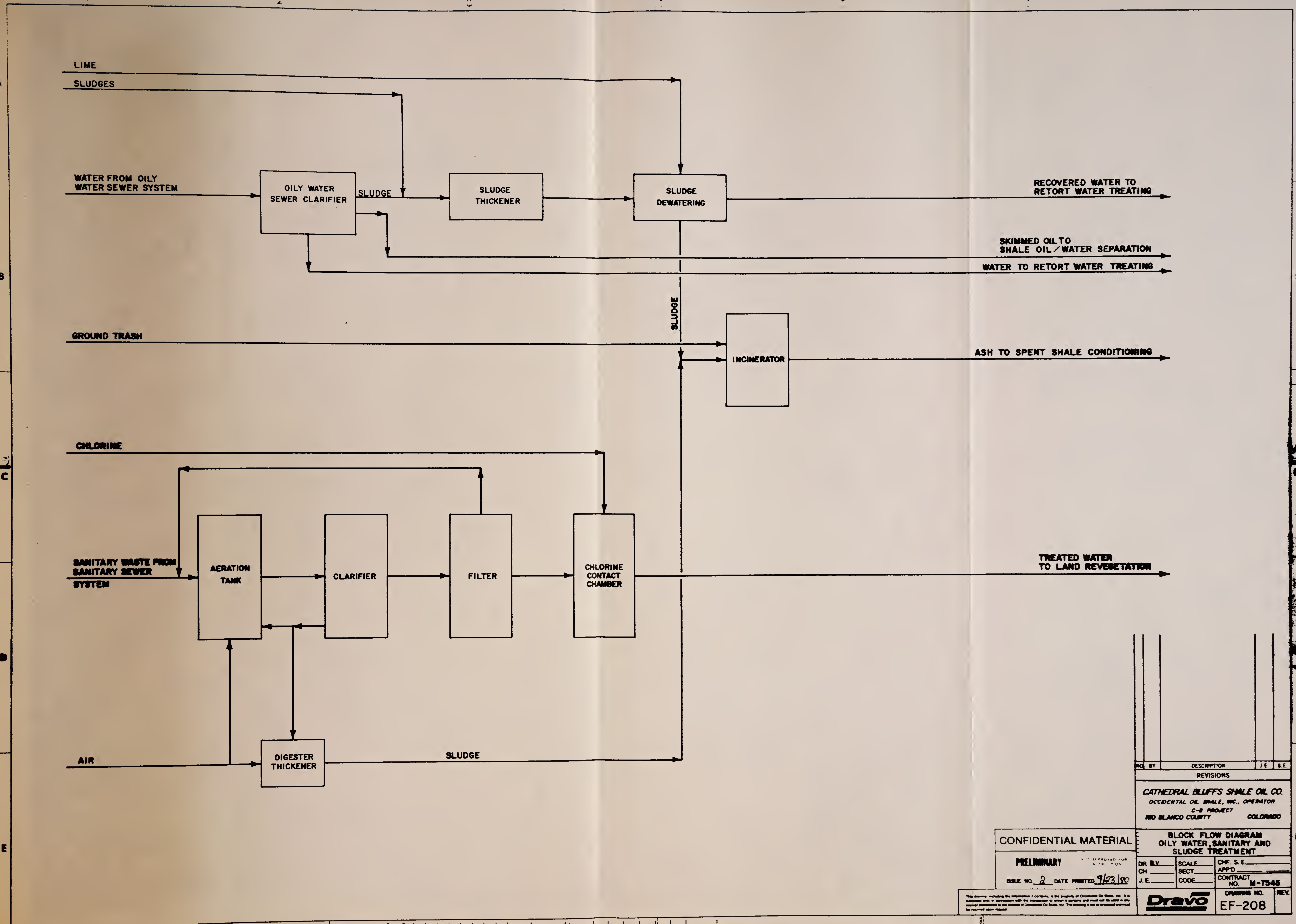
ISSUE NO 2 DATE PRINTED 9/23/80

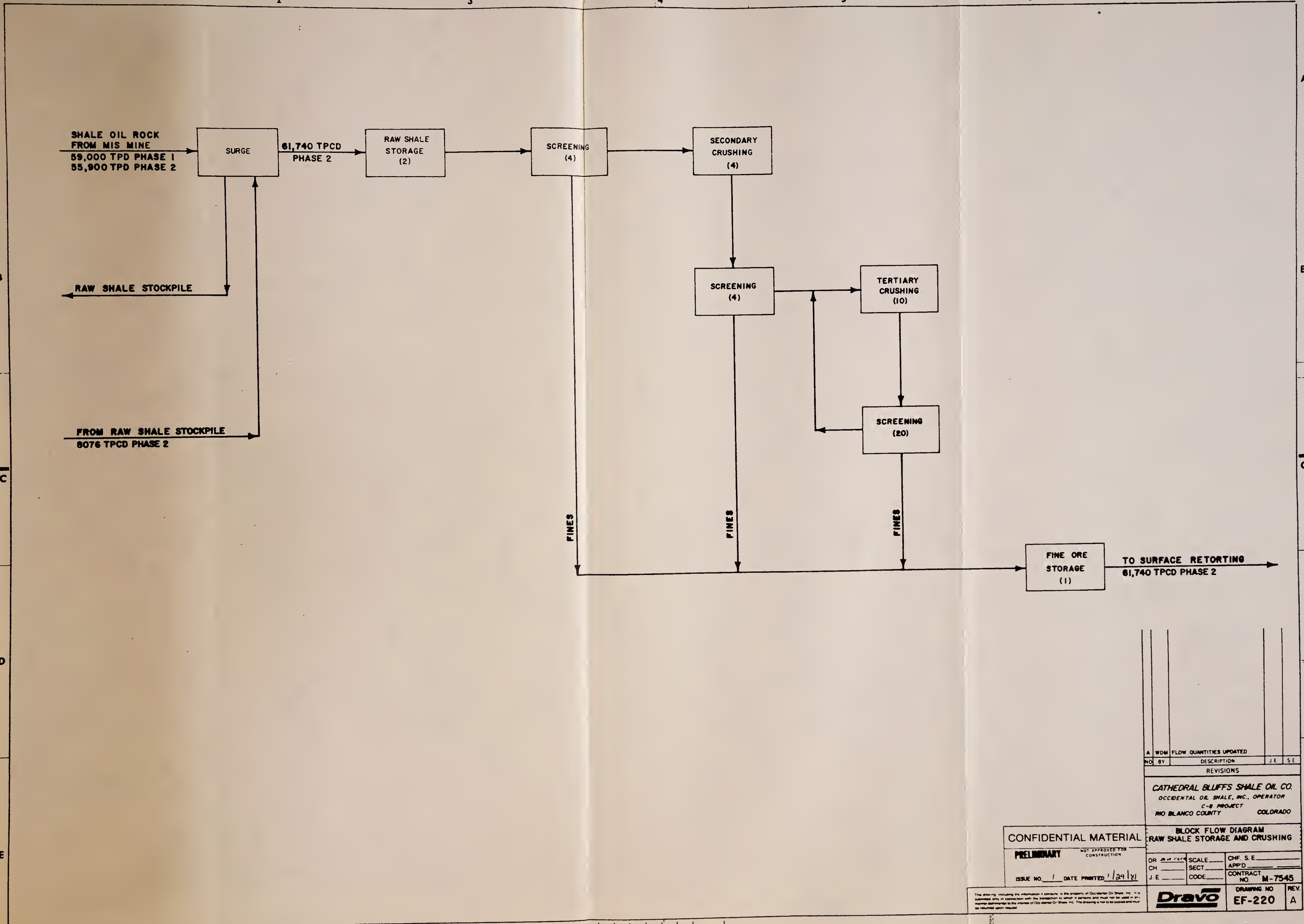
BLOCK FLOW DIAGRAM
MINE WATER TREATING

DR B.Y. CH J.E.
SCALE SECT. CODE
CHF. S.E. APP'D
CONTRACT NO. M-7545

Dravo

DRAWING NO. EF-207 REV. A


LIME
SLUDGES
WATER FROM OILY WATER SEWER SYSTEM
OILY WATER SEWER CLARIFIER
SLUDGE
SLUDGE THICKENER
SLUDGE DEWATERING
RECOVERED WATER TO RETORT WATER TREATING
SKIMMED OIL TO SHALE OIL/WATER SEPARATION
WATER TO RETORT WATER TREATING
SLUDGE
GROUND TRASH
INCINERATOR
ASH TO SPENT SHALE CONDITIONING
CHLORINE
SANITARY WASTE FROM SANITARY SEWER SYSTEM
AERATION TANK
CLARIFIER
FILTER
CHLORINE CONTACT CHAMBER
TREATED WATER TO LAND REVEGETATION
AIR
DIGESTER THICKENER
SLUDGE
NO. | BY | DESCRIPTION | J.E. | S.E.
REVISIONS
CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO
CONFIDENTIAL MATERIAL
PRELIMINARY
ISSUE NO. 2 DATE PRINTED 9/23/80
BLOCK FLOW DIAGRAM
OILY WATER, SANITARY AND SLUDGE TREATMENT
DR B.V.
CH
J.E.
SCALE
SECT.
CODE
CHF. S.E.
APP'D
CONTRACT NO. M-7545
Dravo
DRAWING NO. EF-208
REV.


SHALE OIL ROCK FROM MIS MINE
59,000 TPD PHASE I
55,900 TPD PHASE 2
SURGE
61,740 TPCD PHASE 2
RAW SHALE STORAGE (2)
SCREENING (4)
SECONDARY CRUSHING (4)
RAW SHALE STOCKPILE
SCREENING (4)
TERTIARY CRUSHING (10)
SCREENING (20)
FROM RAW SHALE STOCKPILE
8076 TPCD PHASE 2
FINES
FINES
FINES
FINE ORE STORAGE (1)
TO SURFACE RETORTING
61,740 TPCD PHASE 2
A WDM FLOW QUANTITIES UPDATED
NO BY DESCRIPTION J E S E
REVISIONS
CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO
CONFIDENTIAL MATERIAL
BLOCK FLOW DIAGRAM
RAW SHALE STORAGE AND CRUSHING
PRELIMINARY
NOT APPROVED FOR CONSTRUCTION
ISSUE NO. 1 DATE PRINTED 1/29/81
DR
CH
J E
SCALE
SECT.
CODE
CHF. S. E.
APP'D
CONTRACT NO. M-7545
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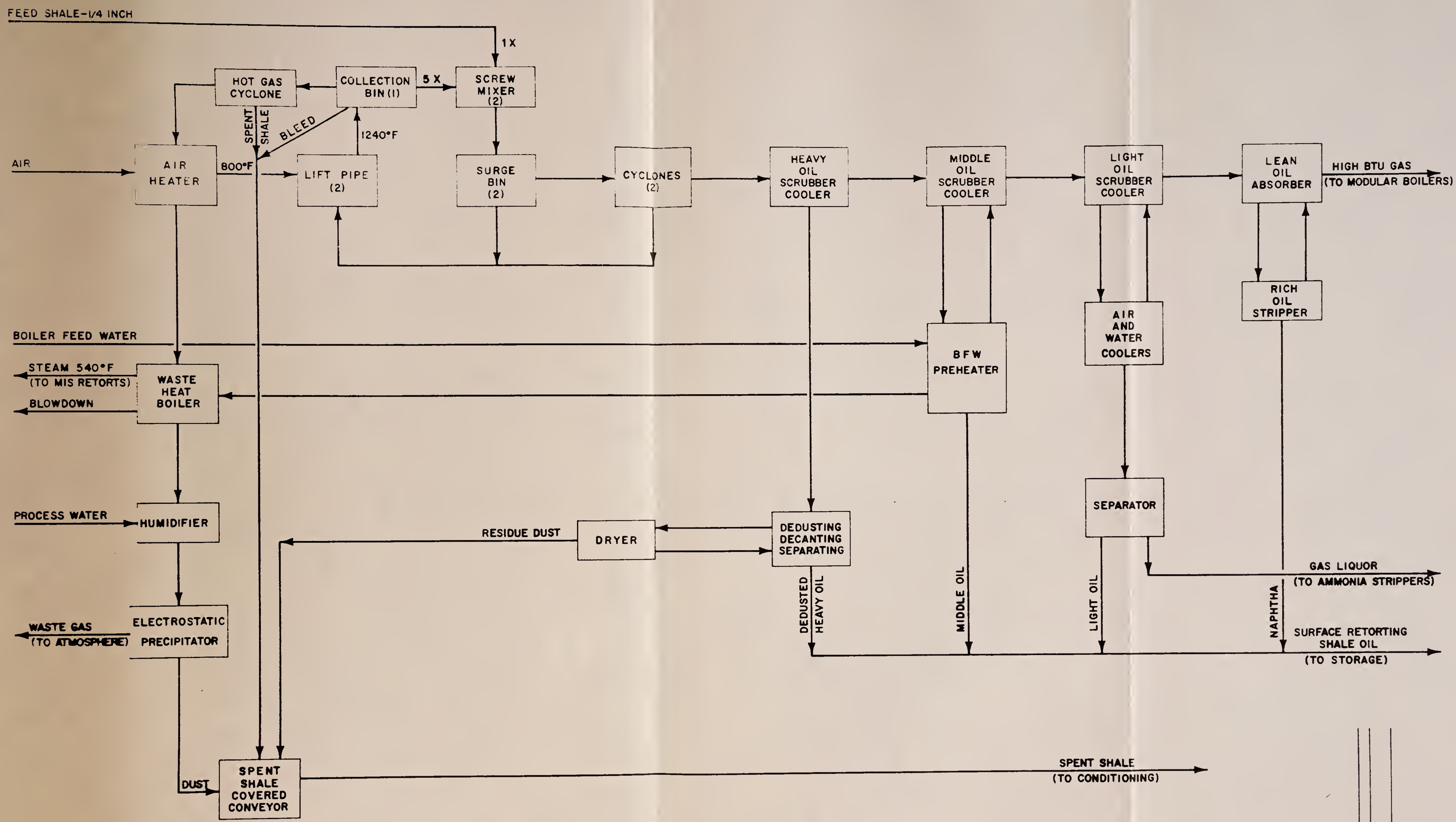
Dravo
DRAWING NO EF-220
REV. A



NO	BY	DESCRIPTION	J E	S E
B	WOM	REDRAWN		

REVISIONS

CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO

LURGI-RUHRGAS PROCESS

CONFIDENTIAL MATERIAL

PRELIMINARY NOT APPROVED FOR CONSTRUCTION

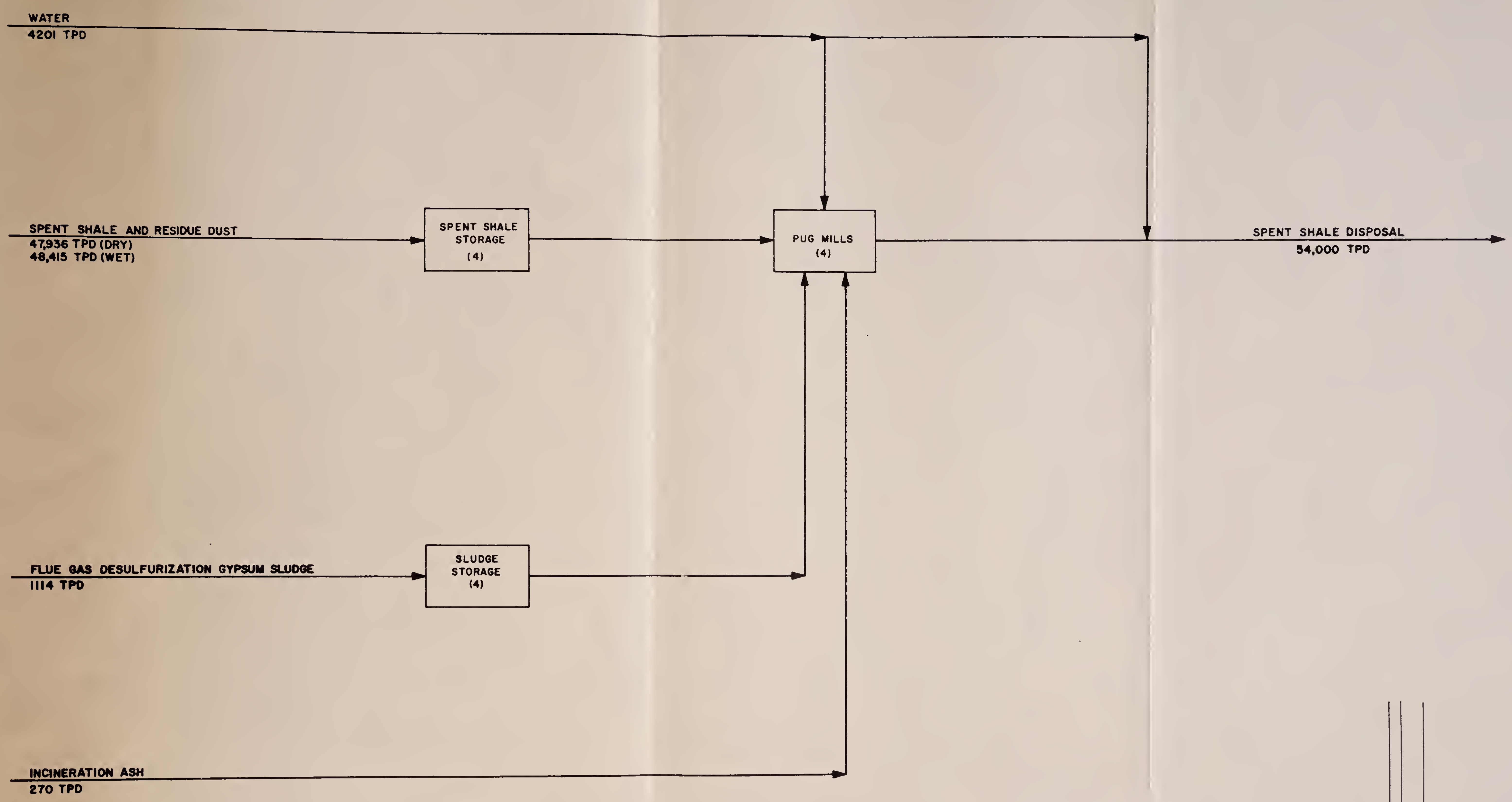
ISSUE NO 1 DATE PRINTED 1/24/81

BLOCK FLOW DIAGRAM
SURFACE RETORTING
PHASE II

DR ___ SCALE ___ CHF S E ___
CH ___ SECT ___ APP'D ___
J E ___ CODE ___ CONTRACT NO

Dravo

DRAWING NO EF-221 REV. B



NO	BY	DESCRIPTION	J E	S E
A	WDM	FLOW QUANTITIES UPDATED		

REVISIONS

CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO

CONFIDENTIAL MATERIAL

PRELIMINARY NOT APPROVED FOR CONSTRUCTION

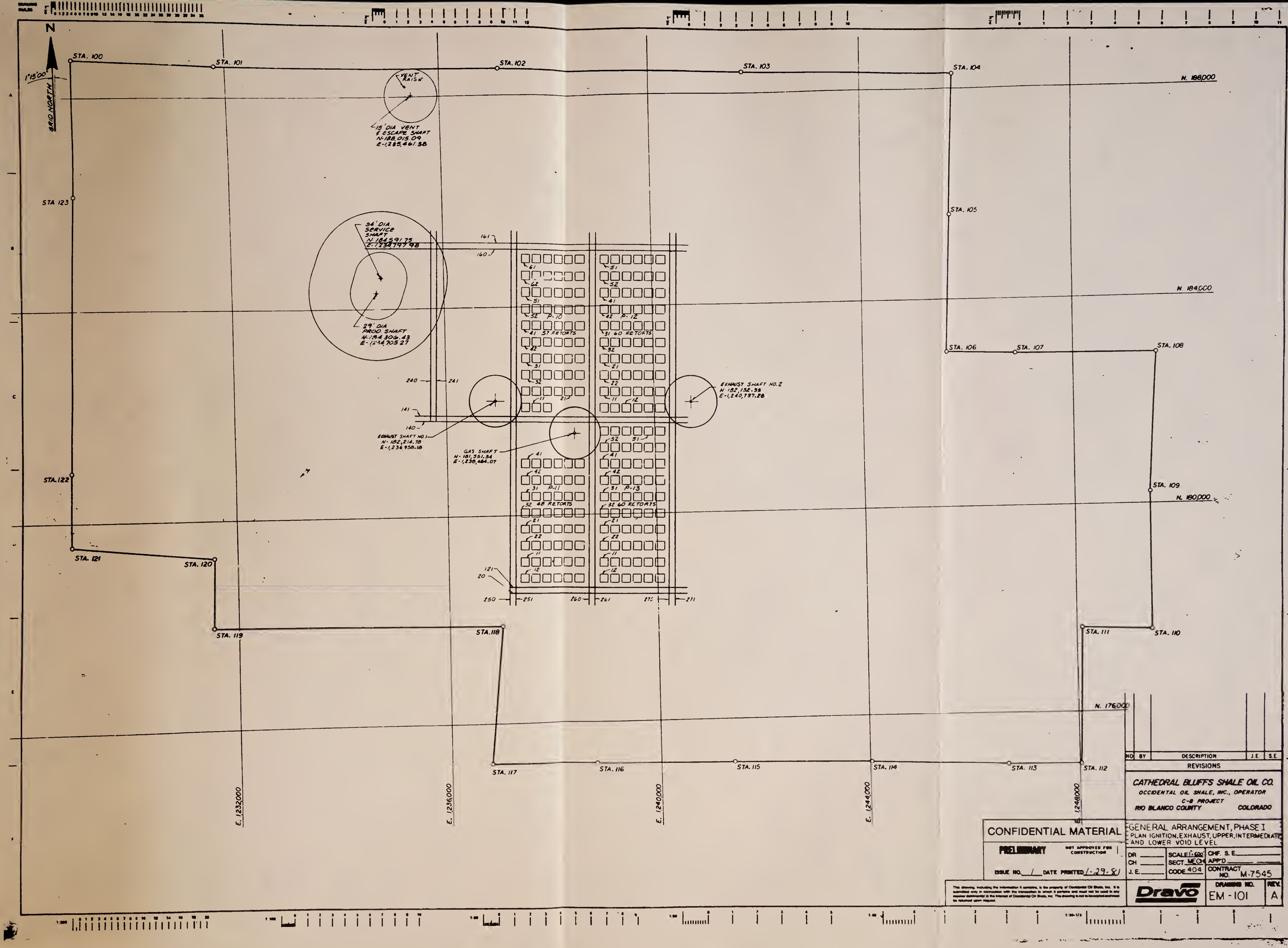
ISSUE NO. 1 DATE PRINTED 1/29/81

BLOCK FLOW DIAGRAM
SPENT SHALE CONDITIONING
PHASE II

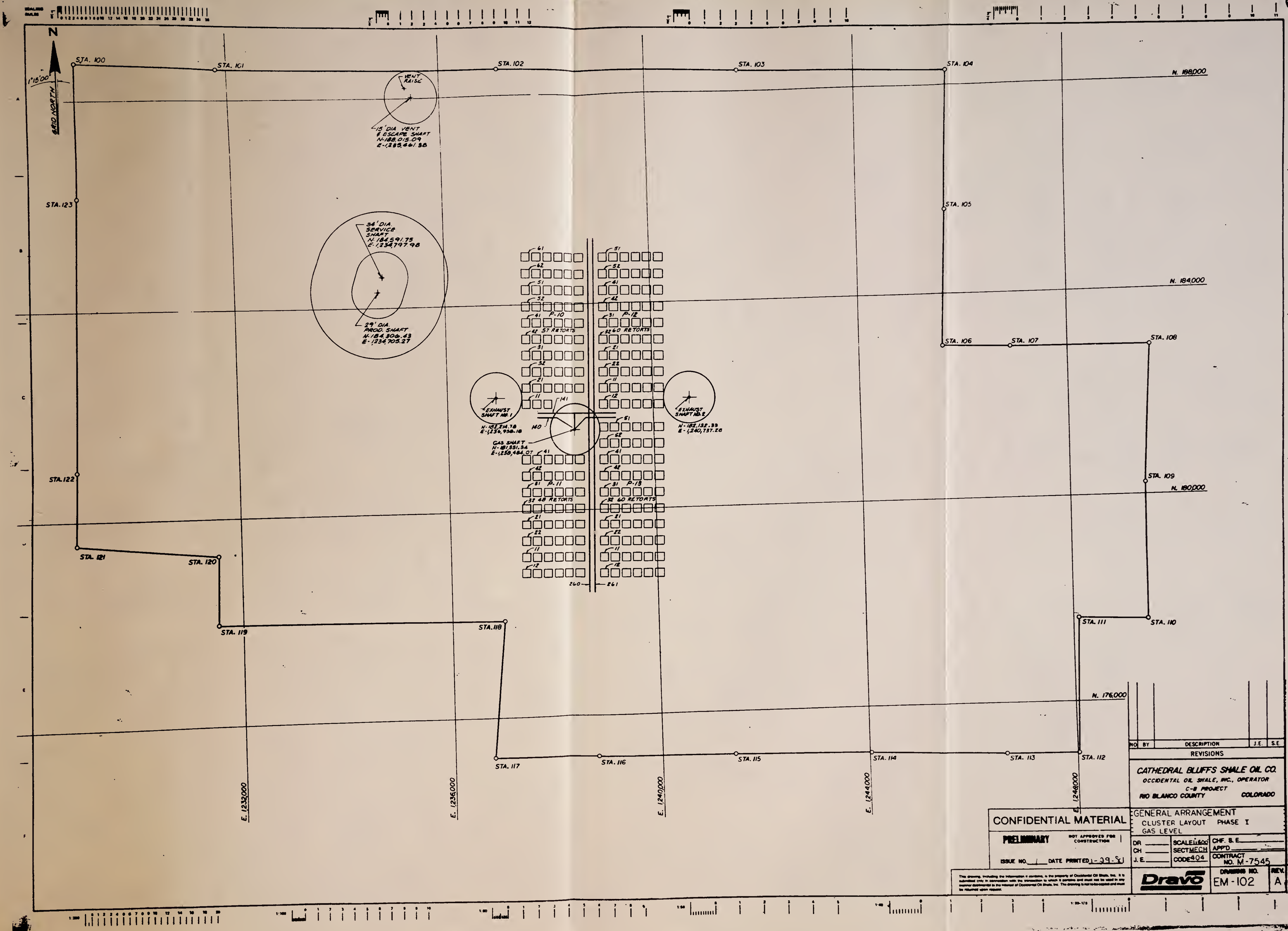
DR ____ CH ____ J E ____
SCALE ____ SECT ____ CODE ____
CHF S.E. ____ APP'D ____
CONTRACT NO M-7545

Dravo

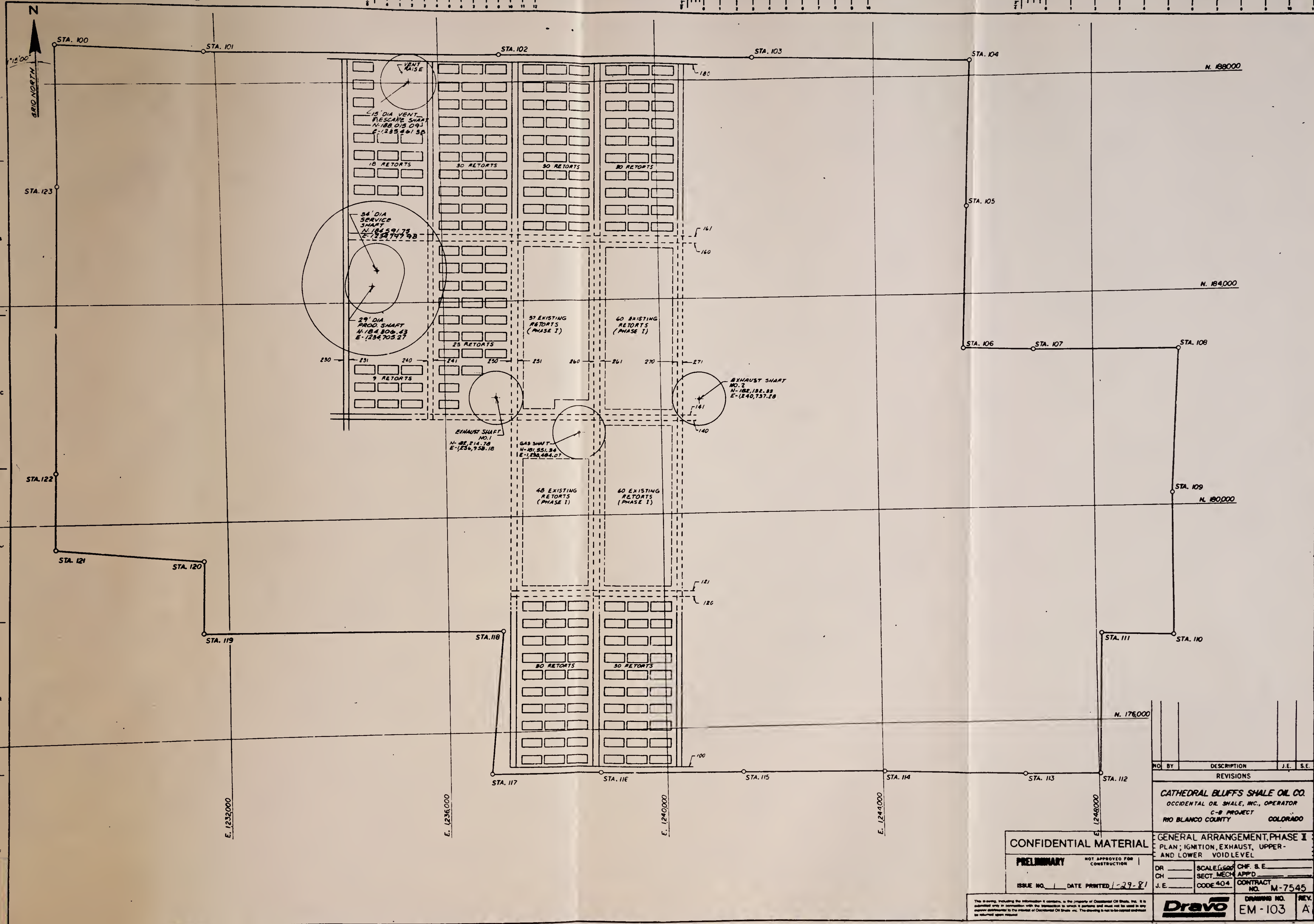
DRAWING NO. EF-222 REV A



N
GRID NORTH
1°15'00"
STA. 100
STA. 101
STA. 102
STA. 103
STA. 104
STA. 105
STA. 106
STA. 107
STA. 108
STA. 109
STA. 110
STA. 111
STA. 112
STA. 113
STA. 114
STA. 115
STA. 116
STA. 117
STA. 118
STA. 119
STA. 120
STA. 121
STA. 122
STA 123
N. 188,000
N. 184,000
N. 180,000
N. 176,000
E. 1,232,000
E. 1,236,000
E. 1,240,000
E. 1,244,000
E. 1,248,000
VENT RAISE
15' DIA VENT & ESCAPE SHAFT N-188,015.09 E-1,235,461.38
34' DIA SERVICE SHAFT
29' DIA PROD SHAFT
P-10 57 RETORTS
P-12 60 RETORTS
P-11 48 RETORTS
P-13 60 RETORTS
EXHAUST SHAFT NO. 1 N-182,214.78 E-1,236,958.18
EXHAUST SHAFT NO. 2 N 182,132.35 E-1,240,737.28
GAS SHAFT N-181,351.34 E-1,238,484.07
CONFIDENTIAL MATERIAL
PRELIMINARY
NOT APPROVED FOR CONSTRUCTION
ISSUE NO. 1 DATE PRINTED 1-29-81
NO BY DESCRIPTION J.E. S.E.
REVISIONS
CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO
GENERAL ARRANGEMENT, PHASE I
PLAN IGNITION, EXHAUST, UPPER, INTERMEDIATE AND LOWER VOID LEVEL
DR
CH
J.E.
SCALE 1"=600'
SECT. MECH
CODE 404
CHF. S.E.
APP'D
CONTRACT NO. M-7545
Dravo
DRAWING NO. EM-101
REV. A



N
GRID NORTH
1°15'00"
STA. 100
STA. 101
STA. 102
STA. 103
STA. 104
N. 188,000
VENT RAISE
15' DIA VENT & ESCAPE SHAFT N-188,015.09 E-1,235,461.38
STA. 123
STA. 105
34' DIA. SERVICE SHAFT N. 184,591.75 E-1,234,797.98
29' DIA. PROD. SHAFT N. 184,306.43 E-1,234,705.27
N. 184,000
P-10 57 RETORTS
P-12 60 RETORTS
STA. 106
STA. 107
STA. 108
EXHAUST SHAFT NO. 1
EXHAUST SHAFT NO. 2
GAS SHAFT
140
141
P-11 48 RETORTS
P-13 60 RETORTS
260
261
STA. 122
STA. 109
N. 180,000
STA. 121
STA. 120
STA. 119
STA. 118
STA. 111
STA. 110
N. 176,000
STA. 117
STA. 116
STA. 115
STA. 114
STA. 113
STA. 112
E. 1,232,000
E. 1,236,000
E. 1,240,000
E. 1,244,000
E. 1,248,000
NO
BY
DESCRIPTION
J.E.
S.E.
REVISIONS
CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY
COLORADO
CONFIDENTIAL MATERIAL
GENERAL ARRANGEMENT
CLUSTER LAYOUT PHASE I
GAS LEVEL
PRELIMINARY
NOT APPROVED FOR CONSTRUCTION
ISSUE NO. 1 DATE PRINTED 1-29-81
DR
CH
J.E.
SCALE 1:600'
SECT MECH
CODE 404
CHF. S.E.
APP'D
CONTRACT NO. M-7545
Dravo
DRAWING NO.
EM-102
REV.
A


N
GRID NORTH
STA. 100
STA. 101
STA. 102
STA. 103
STA. 104
STA. 105
STA. 106
STA. 107
STA. 108
STA. 109
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STA. 112
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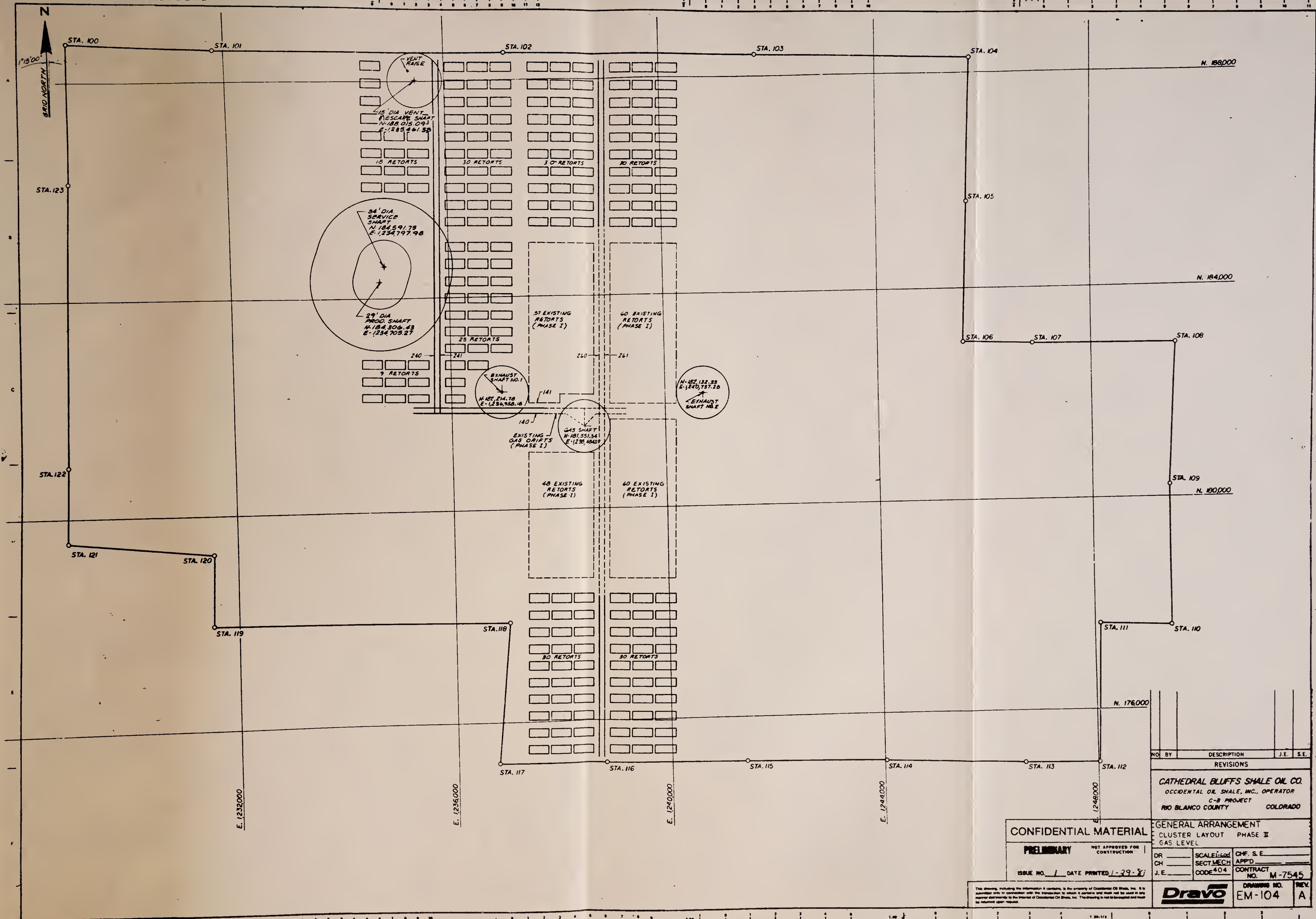
STA. 114
STA. 115
STA. 116
STA. 117
STA. 118
STA. 119
STA. 120
STA. 121
STA. 122
STA. 123
N. 188000
N. 184,000
N. 180,000
N. 176,000
E. 1232000
E. 1236,000
E. 1240,000
E. 1244,000
E. 1248,000
VENT RAISE
15' DIA VENT-ESCAPE SHAFT N-188,013.09 E-1235,461.38
18 RETORTS
30 RETORTS
30 RETORTS
30 RETORTS
34' DIA SERVICE SHAFT
29' DIA PROD. SHAFT N-184,806.63 E-1234,705.27
25 RETORTS
9 RETORTS
57 EXISTING RETORTS (PHASE I)
60 EXISTING RETORTS (PHASE I)
48 EXISTING RETORTS (PHASE I)
60 EXISTING RETORTS (PHASE I)
EXHAUST SHAFT NO. 1 N-182,214.78 E-1236,958.18
GAS SHAFT N-181,551.34 E-1238,464.07
EXHAUST SHAFT NO. 2 N-182,182.85 E-1240,737.28
30 RETORTS
30 RETORTS
180
161
160
141
140
121
120
100
230
231
240
241
250
251
260
261
270
271
NO BY DESCRIPTION J.E. S.E.
REVISIONS
CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO
CONFIDENTIAL MATERIAL
PRELIMINARY
NOT APPROVED FOR CONSTRUCTION
ISSUE NO. 1 DATE PRINTED 1-29-81
GENERAL ARRANGEMENT, PHASE II
PLAN; IGNITION, EXHAUST, UPPER- AND LOWER VOID LEVEL
DR
CH
J.E.
SCALE 1:600
SECT. MECH
CODE 404
CHF. S.E.
APP'D
CONTRACT NO. M-7545
Dravo
DRAWING NO. EM-103
REV. A


N
GRID NORTH
1°15'00"
STA. 100
STA. 101
STA. 102
STA. 103
STA. 104
STA. 105
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STA. 121
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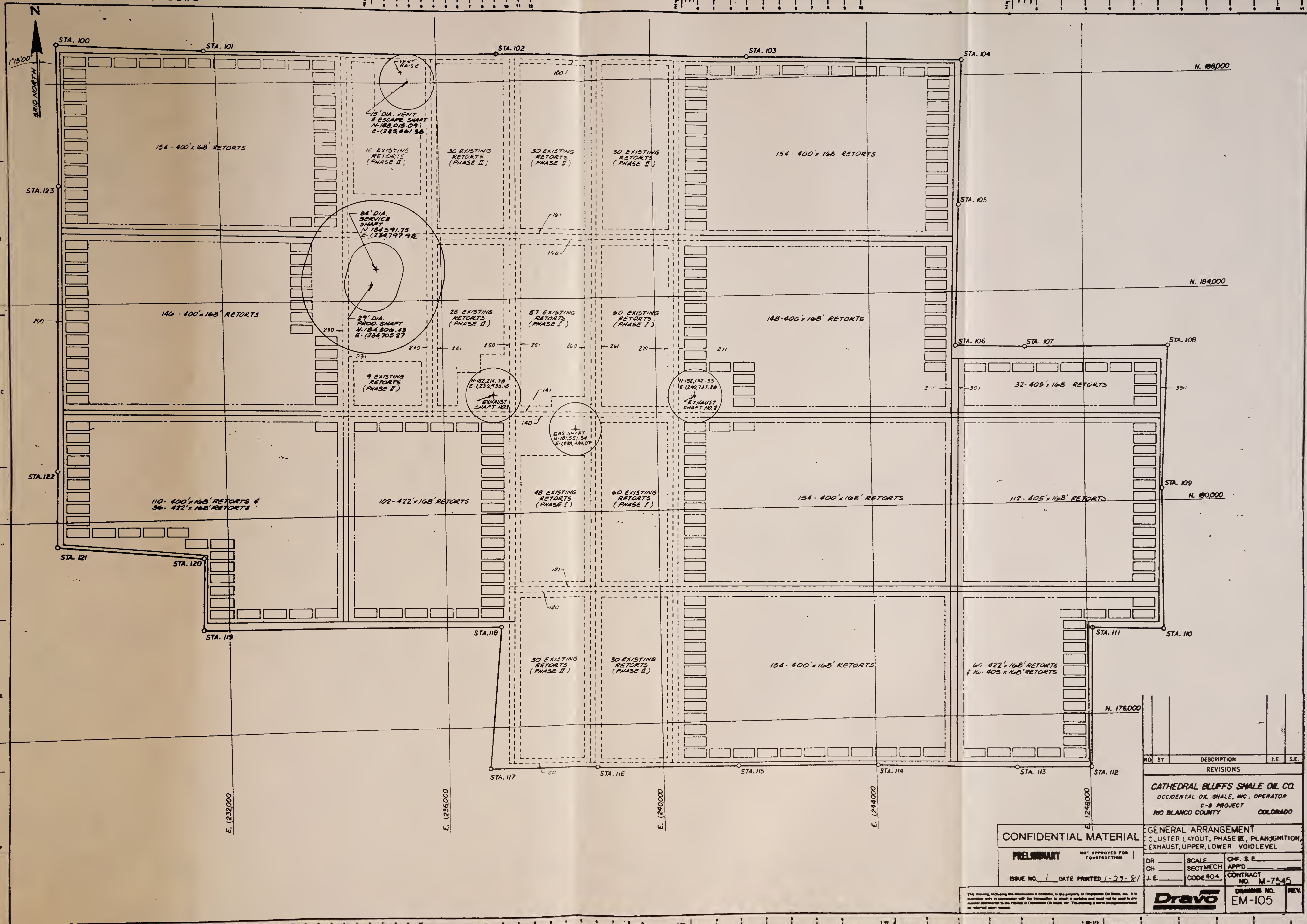
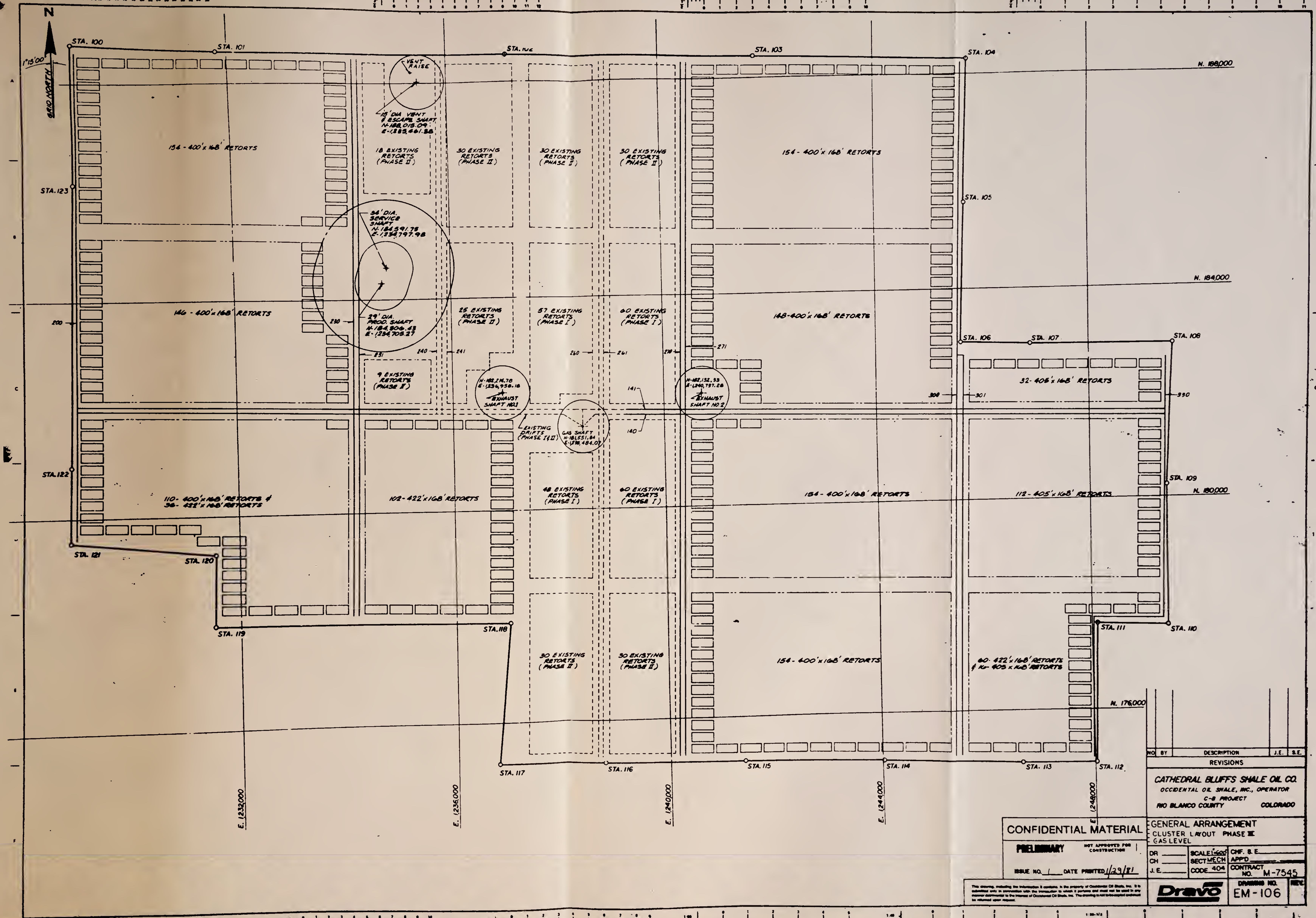
STA. 123
N. 188,000
N. 184,000
N. 180,000
N. 176,000
E. 1232,000
E. 1236,000
E. 1240,000
E. 1244,000
E. 1248,000
VENT RAISE
15' DIA VENT & ESCAPE SHAFT N-188,015.09 E-1235,461.53
18 RETORTS
30 RETORTS
30 RETORTS
30 RETORTS
34' DIA SERVICE SHAFT N-184,591.75 E-1234,797.98
29' DIA PROD. SHAFT N-184,306.43 E-1234,703.27
25 RETORTS
9 RETORTS
240
241
EXHAUST SHAFT NO. 1
N-182,214.78 E-1,236,950.18
141
140
EXISTING GAS DRIFTS (PHASE I)
GAS SHAFT N-181,551.34 E-1238,484.09
57 EXISTING RETORTS (PHASE I)
60 EXISTING RETORTS (PHASE I)
N-182,132.33 E-1,240,737.28
EXHAUST SHAFT NO. 2
48 EXISTING RETORTS (PHASE I)
60 EXISTING RETORTS (PHASE I)
30 RETORTS
30 RETORTS
NO
BY
DESCRIPTION
J.E.
S.E.
REVISIONS
CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY
COLORADO
CONFIDENTIAL MATERIAL
PRELIMINARY
NOT APPROVED FOR CONSTRUCTION
ISSUE NO. 1 DATE PRINTED 1-29-81
GENERAL ARRANGEMENT
CLUSTER LAYOUT PHASE II
GAS LEVEL
DR
CH
J.E.
SCALE 1:600
SECT MECH
CODE 404
CHF. S.E.
APP'D
CONTRACT NO. M-7545
Dravo
DRAWING NO. EM-104
REV. A


N
GRID NORTH
1°15'00"
STA. 100
STA. 101
STA. 102
STA. 103
STA. 104
STA. 105
STA. 106
STA. 107
STA. 108
STA. 109
STA. 110
STA. 111
STA. 112
STA. 113
STA. 114
STA. 115
STA. 116
STA. 117
STA. 118
STA. 119
STA. 120
STA. 121
STA. 122
STA. 123
N. 188,000
N. 184,000
N. 180,000
N. 176,000
E. 1232,000
E. 1236,000
E. 1240,000
E. 1244,000
E. 1248,000
VENT RAISE
13' DIA. VENT & ESCAPE SHAFT N-188,015.09 E-1,235,461.38
34' DIA. SERVICE SHAFT N-184,591.75 E-1,234,797.98
29' DIA. PROD. SHAFT N-184,306.43 E-1,234,705.27
EXHAUST SHAFT NO.1
EXHAUST SHAFT NO.2
GAS SHAFT
154 - 400' x 168' RETORTS
16 EXISTING RETORTS (PHASE II)
30 EXISTING RETORTS (PHASE II)
30 EXISTING RETORTS (PHASE II)
30 EXISTING RETORTS (PHASE II)
154 - 400' x 168' RETORTS
146 - 400' x 168' RETORTS
25 EXISTING RETORTS (PHASE II)
57 EXISTING RETORTS (PHASE I)
60 EXISTING RETORTS (PHASE I)
148-400' x 168' RETORTS
9 EXISTING RETORTS (PHASE II)
32-405' x 168' RETORTS
110- 400' x 168' RETORTS & 36- 422' x 168' RETORTS
102- 422' x 168' RETORTS
48 EXISTING RETORTS (PHASE I)
60 EXISTING RETORTS (PHASE I)
154 - 400' x 168' RETORTS
112 - 405' x 168' RETORTS
30 EXISTING RETORTS (PHASE II)
30 EXISTING RETORTS (PHASE II)
154 - 400' x 168' RETORTS
66 422' x 168' RETORTS & 16- 405 x 168' RETORTS
NO
BY
DESCRIPTION
J.E.
S.E.
REVISIONS
CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY
COLORADO
CONFIDENTIAL MATERIAL
PRELIMINARY
NOT APPROVED FOR CONSTRUCTION
ISSUE NO. 1 DATE PRINTED 1-29-81
GENERAL ARRANGEMENT
CLUSTER LAYOUT, PHASE III, PLAN, IGNITION, EXHAUST, UPPER, LOWER VOID LEVEL
DR
CH
J.E.
SCALE
SECT MECH
CODE 404
CHF. S.E.
APP'D
CONTRACT NO. M-7545
Dravo
DRAWING NO.
EM-105
REV.



NO	BY	DESCRIPTION	J.E.	S.E.

REVISIONS

CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO

CONFIDENTIAL MATERIAL

PRELIMINARY NOT APPROVED FOR CONSTRUCTION

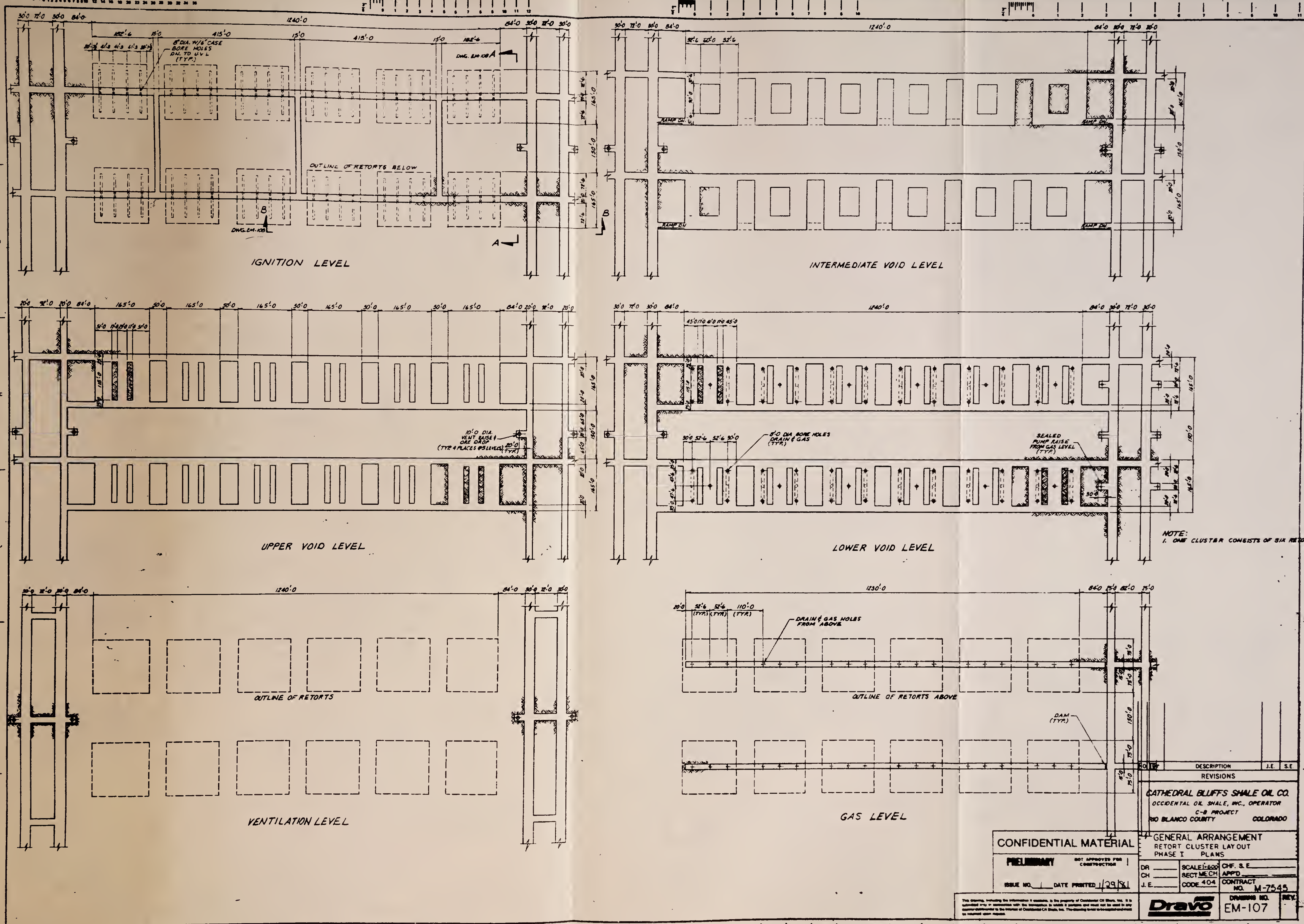
ISSUE NO. 1 DATE PRINTED 1/29/81

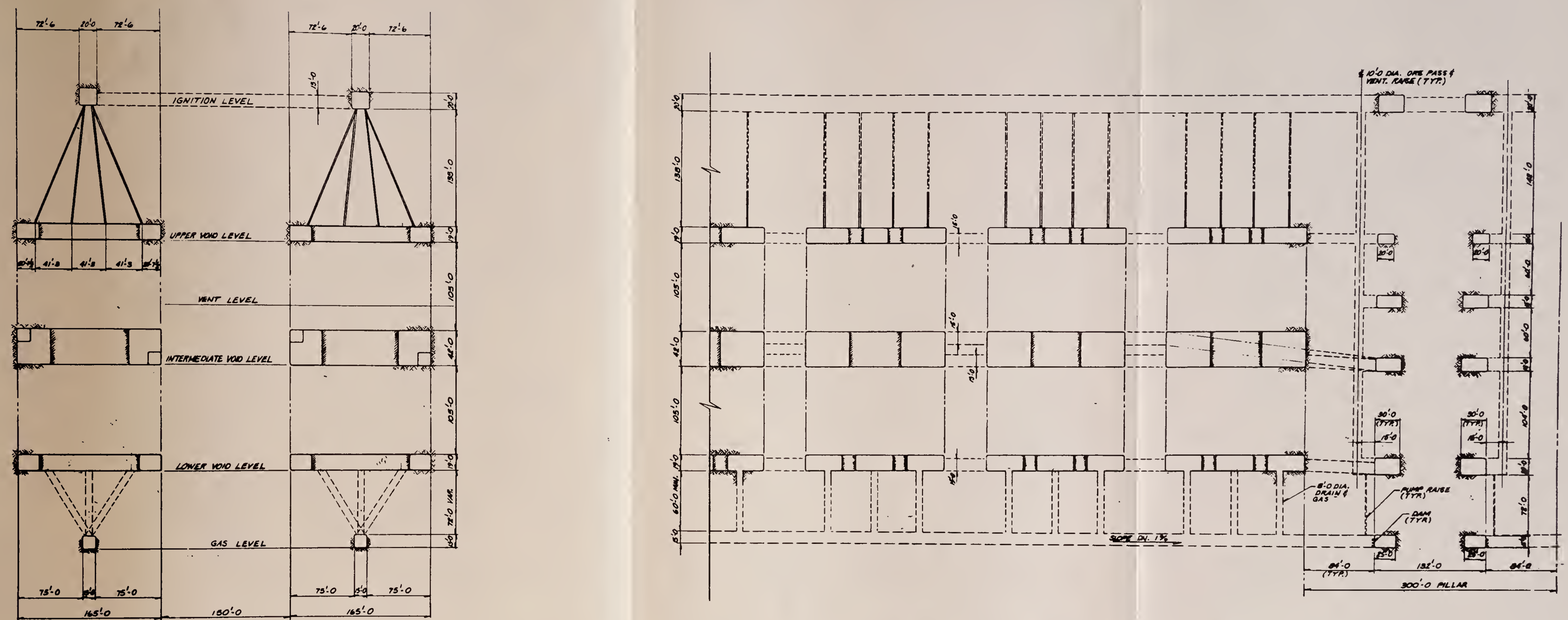
GENERAL ARRANGEMENT
CLUSTER LAYOUT PHASE III
GAS LEVEL

DR ____ SCALE 1"=600' CHF. S.E. ____
CH ____ SECT MECH APP'D ____
J.E. ____ CODE 404 CONTRACT NO. M-7545

Dravo

DRAWING NO. EM-106 REV.


IGNITION LEVEL
8" DIA. W/6" CASE BORE HOLES DN. TO U.V.L (TYP.)
OUTLINE OF RETORTS BELOW
DWG. EM-108
INTERMEDIATE VOID LEVEL
RAMP DN.
UPPER VOID LEVEL
10'-0 DIA. VENT RAISE & ORE DROP (TYP 4 PLACES @ 5 LEVELS)
LOWER VOID LEVEL
8"-0 DIA BORE HOLES DRAIN & GAS (TYP.)
SEALED PUMP RAISE FROM GAS LEVEL (TYP.)
NOTE:
1. ONE CLUSTER CONSISTS OF SIX RETORT
VENTILATION LEVEL
OUTLINE OF RETORTS
GAS LEVEL
DRAIN & GAS HOLES FROM ABOVE
OUTLINE OF RETORTS ABOVE
DAM (TYP.)
NO. DESCRIPTION J.E. S.E.
REVISIONS
CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO
CONFIDENTIAL MATERIAL
PRELIMINARY
NOT APPROVED FOR CONSTRUCTION
ISSUE NO. 1 DATE PRINTED 1/29/81
GENERAL ARRANGEMENT
RETORT CLUSTER LAYOUT
PHASE I PLANS
DR
CH
J.E.
SCALE 1"=600'
SECT MECH
CODE 404
CHF. S.E.
APP'D
CONTRACT NO. M-7545
Dravo
DRAWING NO. EM-107
REV.



SECTION A-A
LOOKING WEST
FROM DWG. EM-107

SECTION B-B
LOOKING NORTH
FROM DWG. EM-107

NO.	BY	DESCRIPTION	J.E.	S.E.

REVISIONS

CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO

CONFIDENTIAL MATERIAL

PRELIMINARY — NOT APPROVED FOR CONSTRUCTION

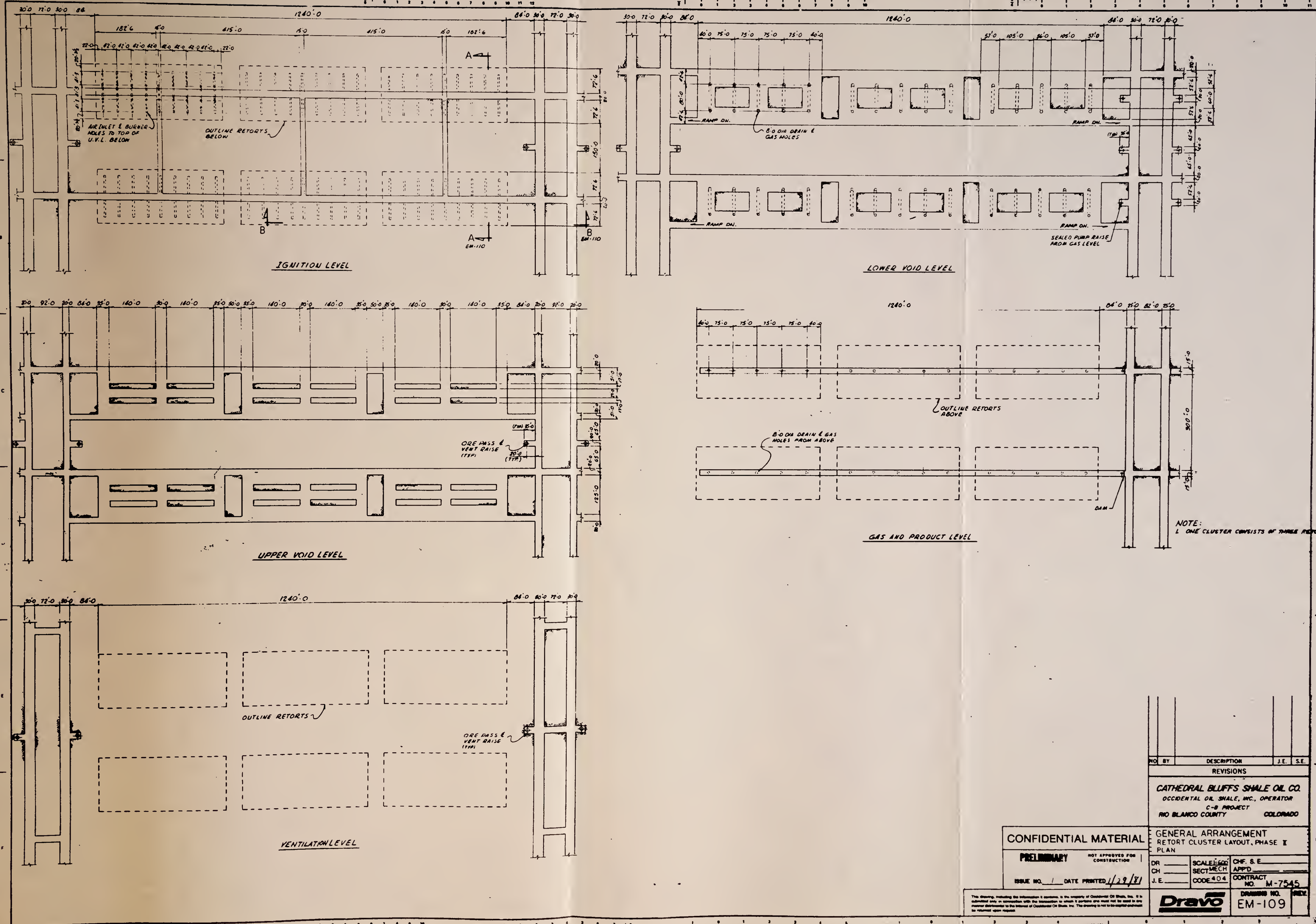
ISSUE NO. 1 DATE PRINTED 1/29/81

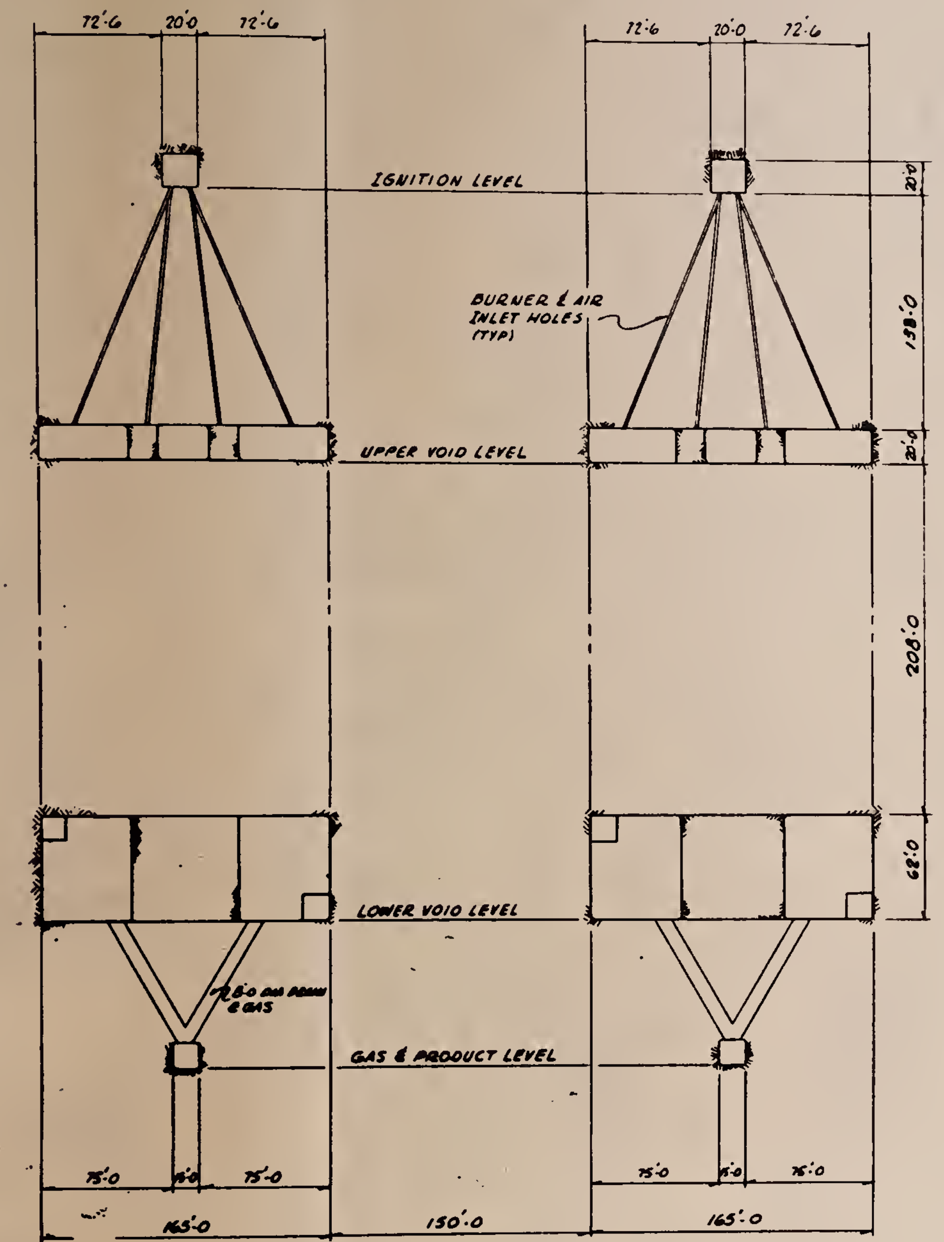
GENERAL ARRANGEMENT
RETORT CLUSTER LAYOUT, PHASE I
SECTIONS

DR. ______ SCALE 1"=600' CHF. S.E. ______
CH ______ SECT. MECH APP'D ______
J.E. ______ CODE 404 CONTRACT NO. M-7545

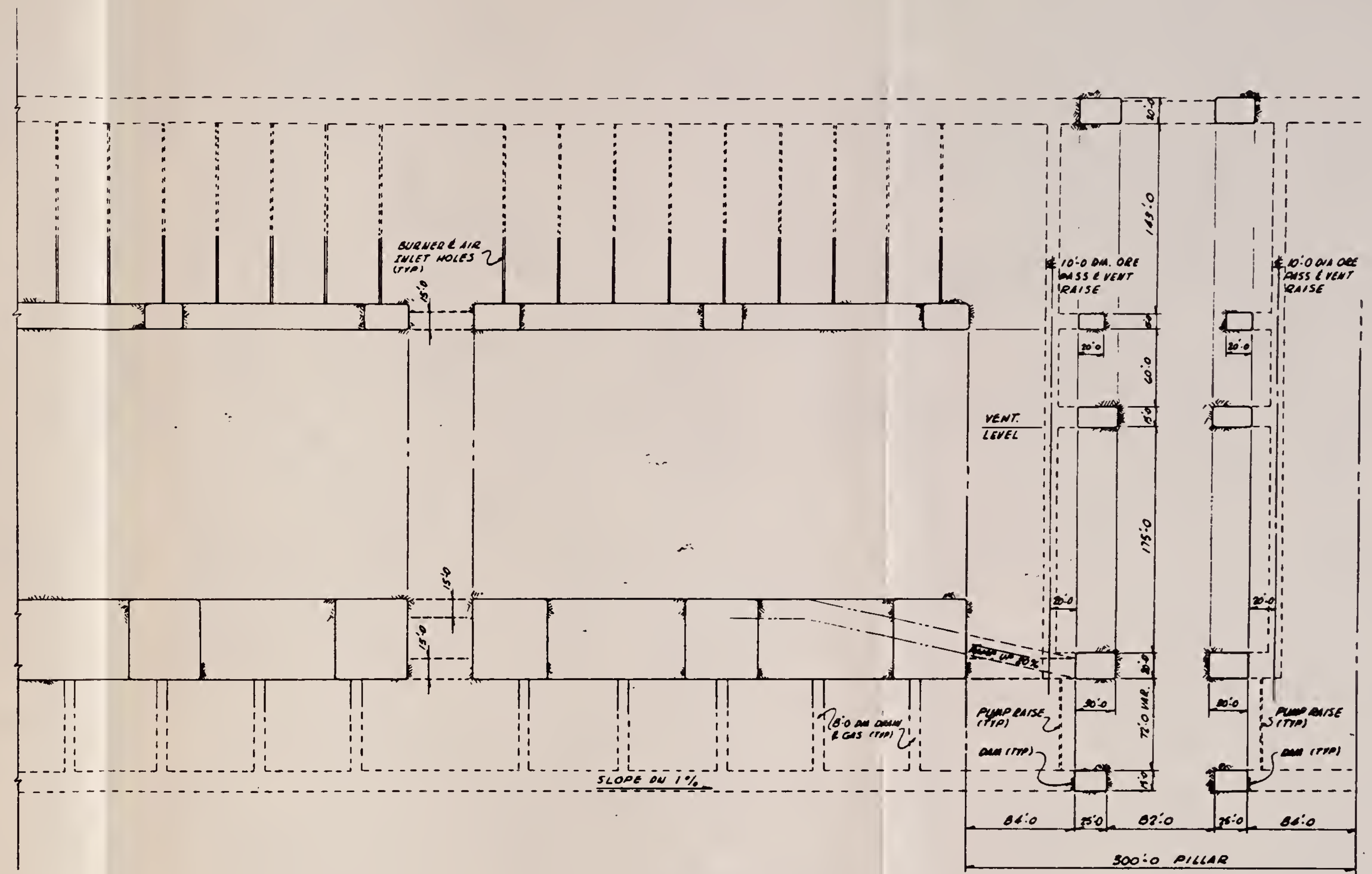
Dravo

DRAWING NO. EM-108 REV.


IGNITION LEVEL
AIR INLET & BURNER HOLES TO TOP OF U.V.L. BELOW
OUTLINE RETORTS BELOW
LOWER VOID LEVEL
8'0 DIA DRAIN & GAS HOLES
RAMP DN.
SEALED PUMP RAISE FROM GAS LEVEL
UPPER VOID LEVEL
ORE PASS & VENT RAISE (TYP)
GAS AND PRODUCT LEVEL
OUTLINE RETORTS ABOVE
8'0 DIA DRAIN & GAS HOLES FROM ABOVE
DAM
NOTE:
1. ONE CLUSTER CONSISTS OF THREE RETOR
VENTILATION LEVEL
OUTLINE RETORTS
ORE PASS & VENT RAISE (TYP)
NO BY DESCRIPTION J.E. S.E.
REVISIONS
CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO
CONFIDENTIAL MATERIAL
PRELIMINARY
NOT APPROVED FOR CONSTRUCTION
ISSUE NO. 1 DATE PRINTED 1/29/81
GENERAL ARRANGEMENT
RETORT CLUSTER LAYOUT, PHASE II
PLAN
DR
CH
J.E.
SCALE 1:600'
SECT MECH
CODE 404
CHF. S.E.
APP'D
CONTRACT NO. M-7545
Dravo
DRAWING NO. EM-109
REV.



SECTION A-A
LOOKING WEST
DWG. EM-109



SECTION B-B
LOOKING NORTH
DWG EM-109

NO	BY	DESCRIPTION	J.E.	S.E.

REVISIONS

CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO

CONFIDENTIAL MATERIAL

PRELIMINARY — NOT APPROVED FOR CONSTRUCTION

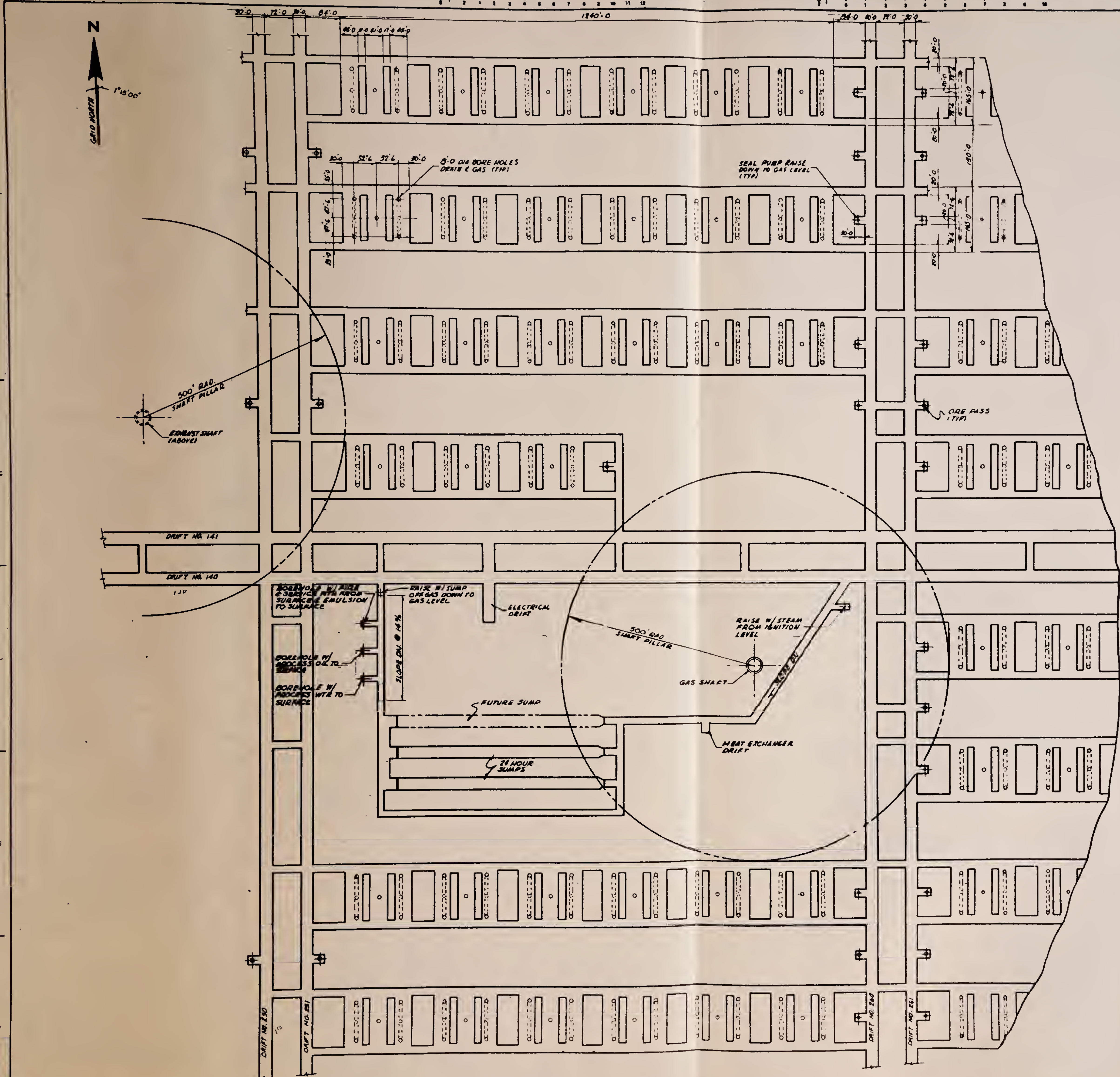
ISSUE NO. 1 DATE PRINTED 1/29/81

GENERAL ARRANGEMENT
RETORT CLUSTER LAYOUT, PHASE II
SECTION

DR ____ CH ____ J.E. ____
SCALE 1:600 SECT MECH CODE 404
CHF. & E. ____ APP'D ____
CONTRACT NO. M-7545

Dravo

DRAWING NO. EM-110 REV.



REFERENCE DRAWINGS

EM-107 G.A. RETORT CLUSTER LAYOUT PLANS

EM-101 G.A. CLUSTER LAYOUT, IGNITION LEVEL UPPER, INTERM. & LOWER VOID LEVELS

NO	BY	DESCRIPTION	J.E.	S.E.
		REVISIONS		

CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO

CONFIDENTIAL MATERIAL

PRELIMINARY — NOT APPROVED FOR CONSTRUCTION

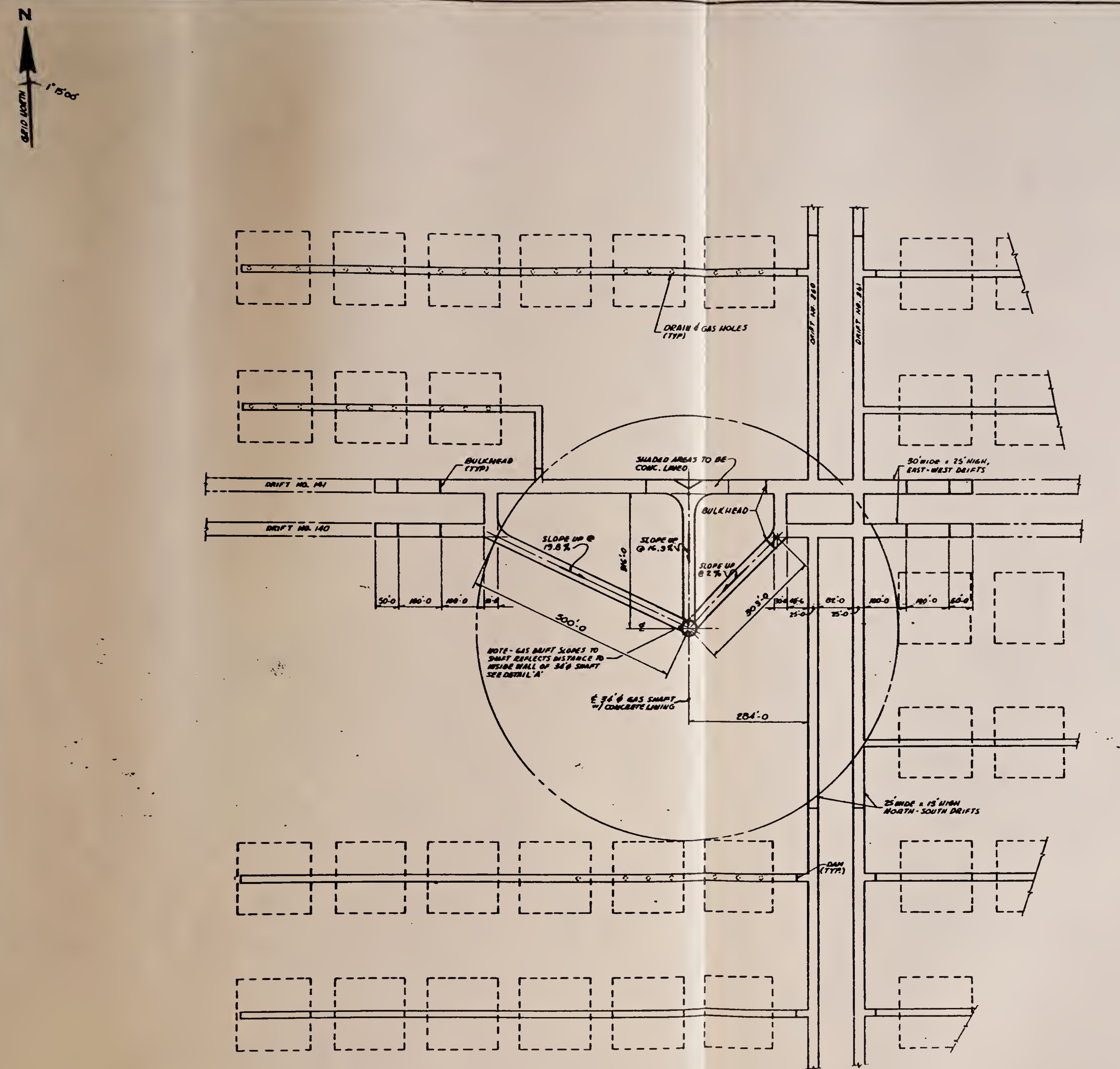
ISSUE NO. 1 DATE PRINTED 11-4-81

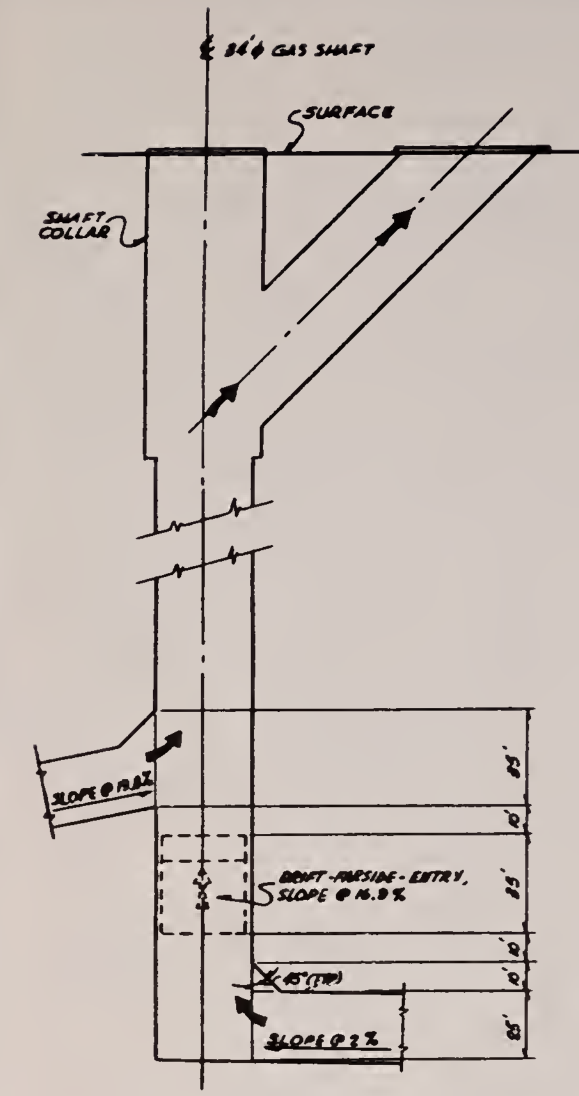
GENERAL ARRANGEMENT
ENLARGED CLUSTER LAYOUT
LOWER VOID LEVEL

DR ____ CH ____ J.E. ____
SCALE 1"=100' SECT MECH CODE 404
CHF. S.E. ____ APP'D ____
CONTRACT NO. M-7545

Dravo

DRAWING NO. EM-111 REV.





DETAIL 'A'
GAS DRIFT SLOPES
1" = 30'-0

NO	BY	DESCRIPTION	J.E.	S.E.

REVISIONS

CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO

CONFIDENTIAL MATERIAL

PRELIMINARY — NOT APPROVED FOR CONSTRUCTION

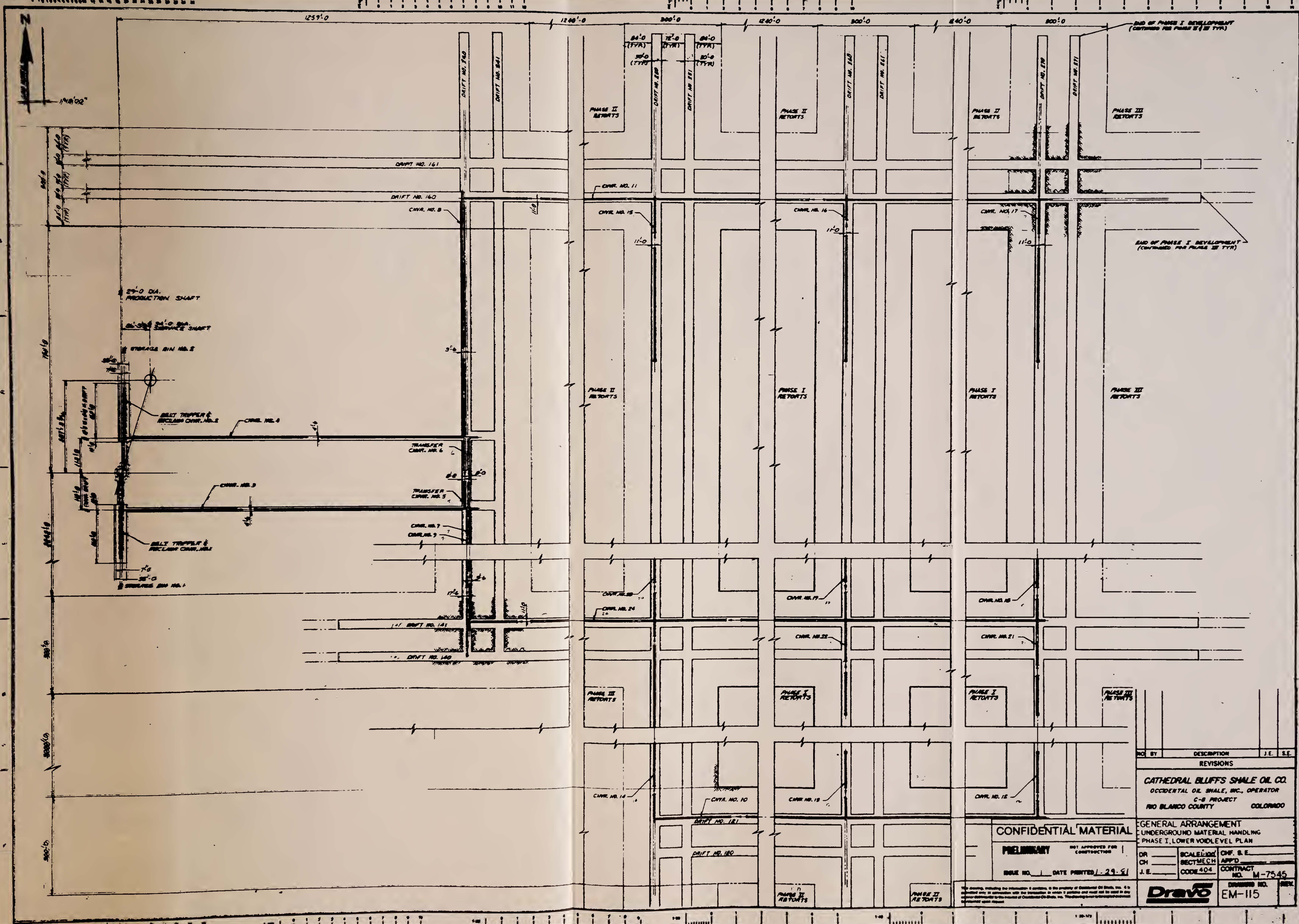
ISSUE NO. 1 DATE PRINTED 1-29-81

GENERAL ARRANGEMENT
ENLARGED CLUSTER LAYOUT
GASLEVEL AT GASSHAFT

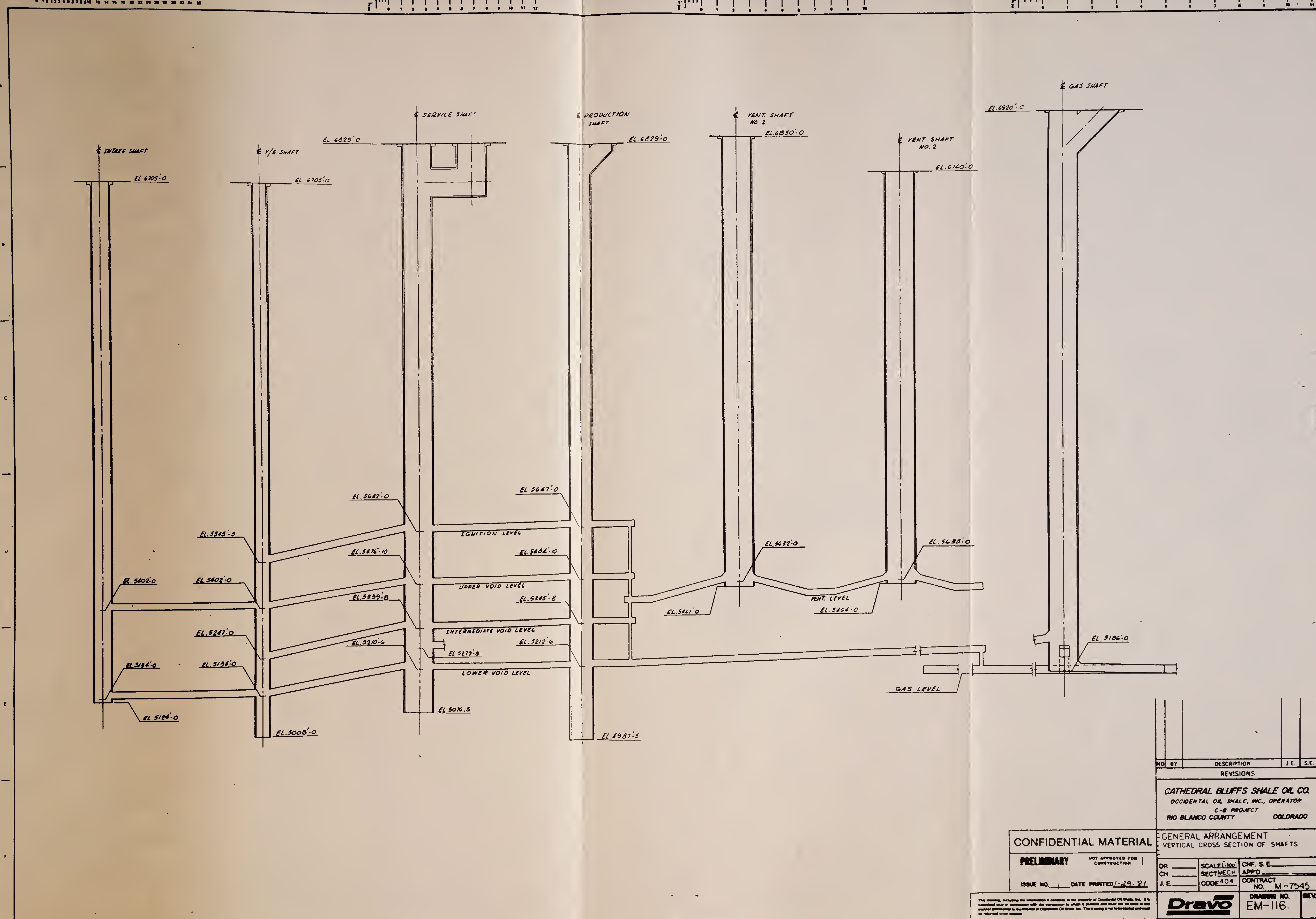
DR ____ CH ____ J.E. ____
SCALE 1"=100' SECT MECH CODE 404
CHF. S.E. ____ APP'D ____
CONTRACT NO. M-7565

Dravo

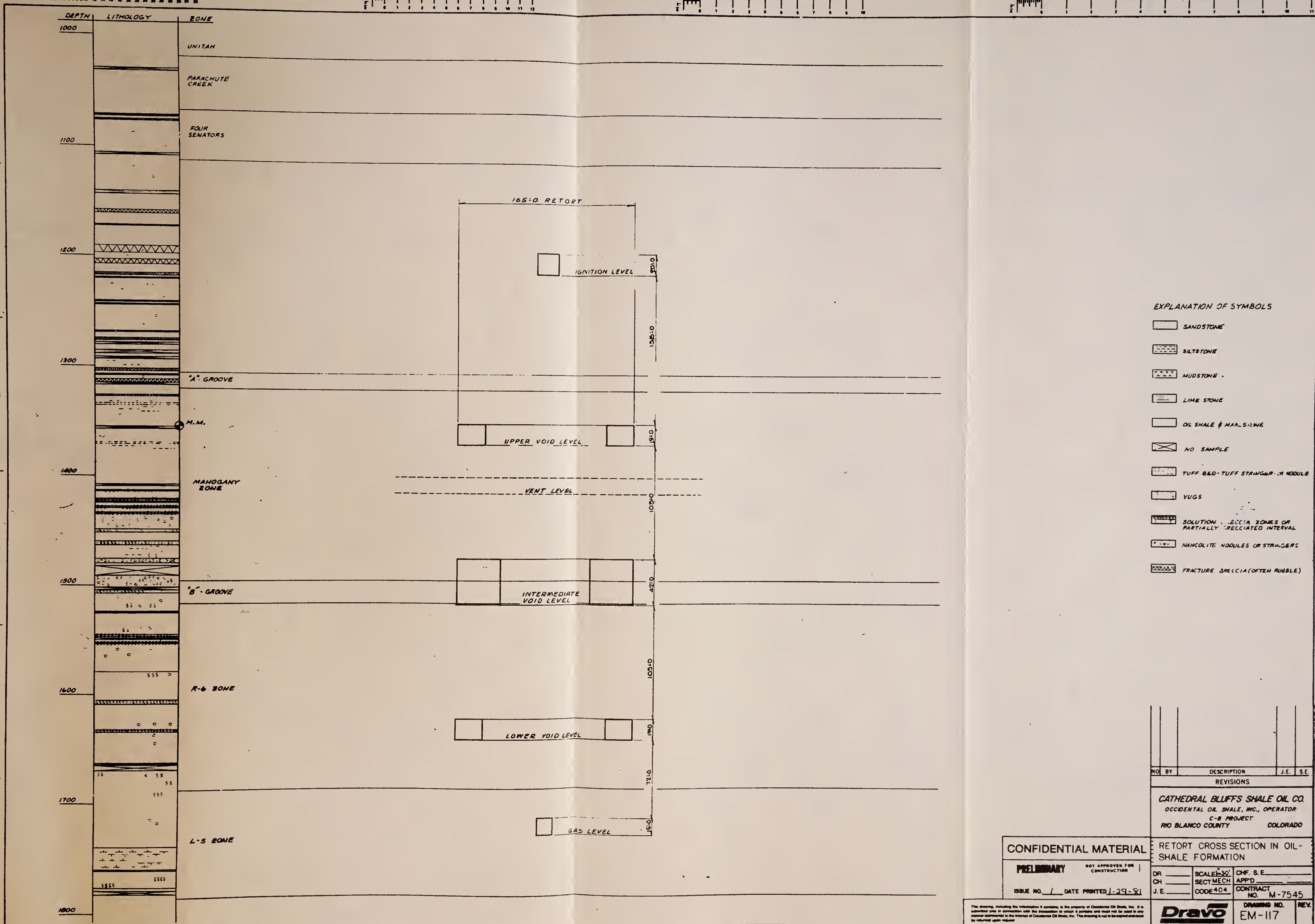
DRAWING NO. EM-114

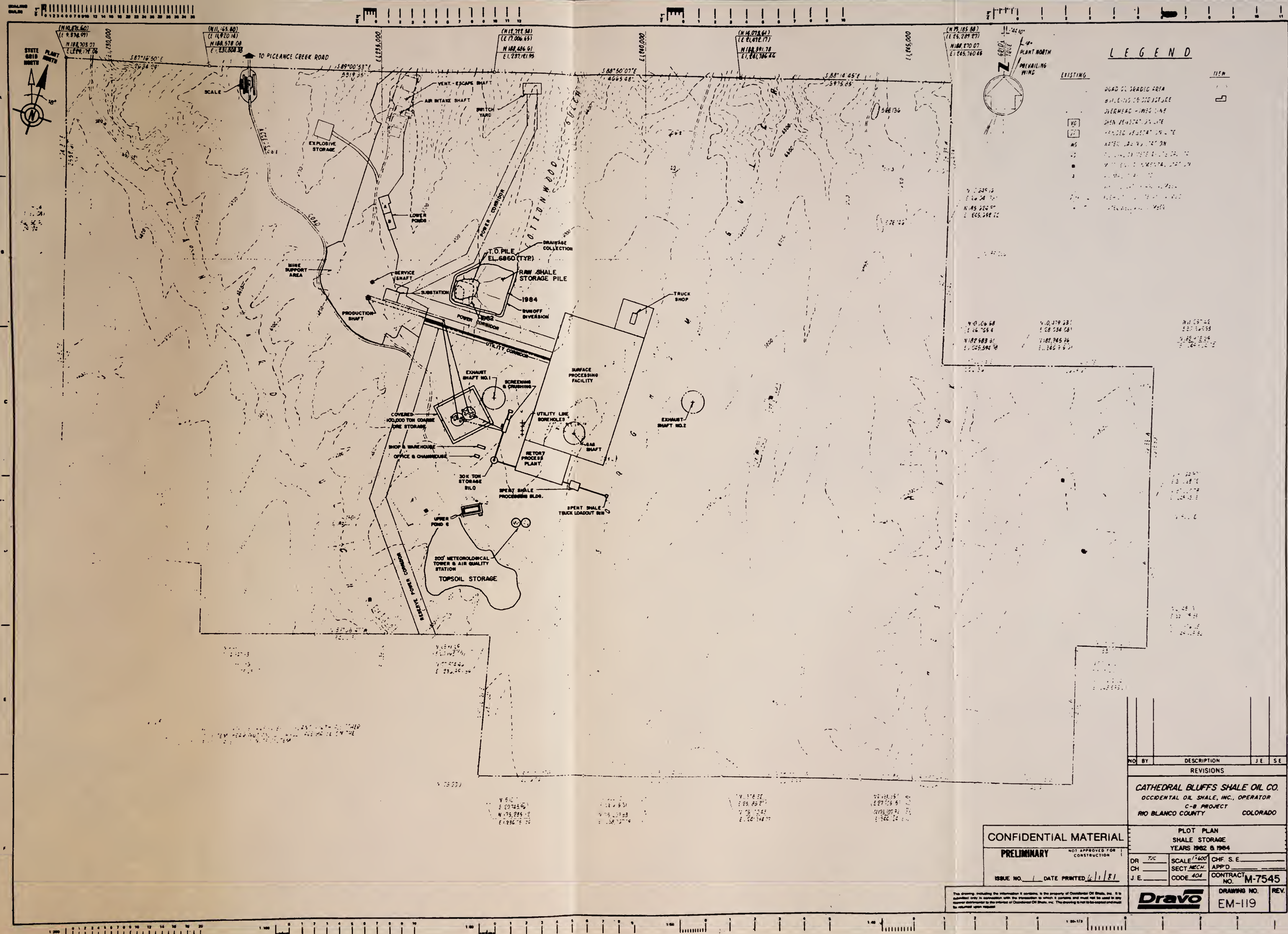


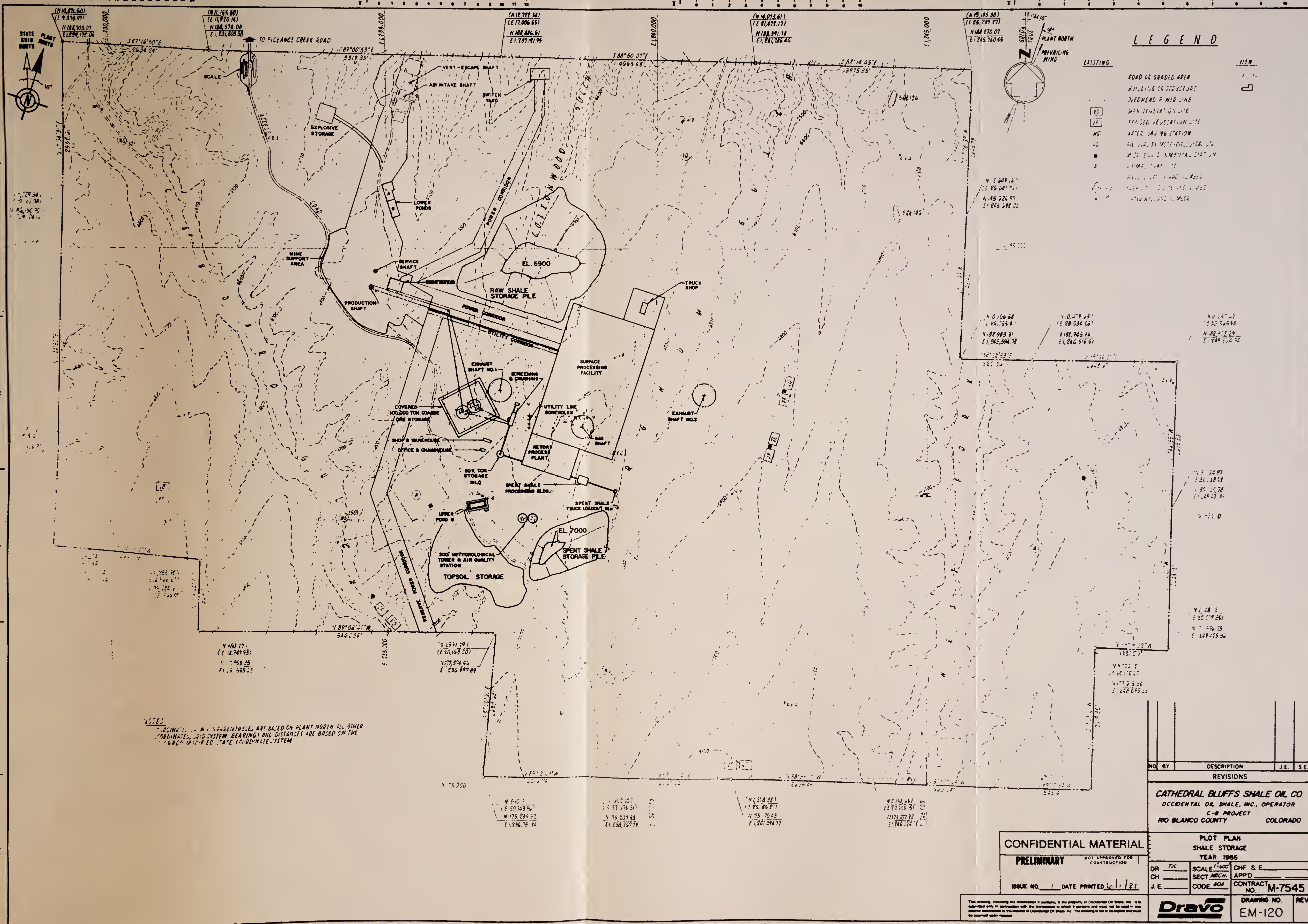
N
DRIFT NO. 161
DRIFT NO. 160
CHVR. NO. 8
CHVR. NO. 11
CHVR. NO. 15
CHVR. NO. 16
CHVR. NO. 17
PHASE II RETORTS
PHASE III RETORTS
PHASE I RETORTS
END OF PHASE I DEVELOPMENT
29'-0 DIA. PRODUCTION SHAFT
SERVICE SHAFT
STORAGE BIN NO. 2
BELT TRIPPER & RECLAIM CNVR. NO. 2
CNVR. NO. 4
TRANSFER CNVR. NO. 6
CNVR. NO. 3
TRANSFER CNVR. NO. 5
CNVR. NO. 7
CNVR. NO. 9
BELT TRIPPER & RECLAIM CNVR. NO. 1
STORAGE BIN NO. 1
DRIFT NO. 141
DRIFT NO. 140
CNVR. NO. 24
CNVR. NO. 19
CNVR. NO. 18
CNVR. NO. 22
CNVR. NO. 21
CNVR. NO. 14
CNVR. NO. 10
CNVR. NO. 13
CNVR. NO. 12
DRIFT NO. 181
DRIFT NO. 180
NO. | BY | DESCRIPTION | J.E. | S.E.
REVISIONS
CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO
CONFIDENTIAL MATERIAL
PRELIMINARY
NOT APPROVED FOR CONSTRUCTION
ISSUE NO. 1 DATE PRINTED 1-29-81
GENERAL ARRANGEMENT
UNDERGROUND MATERIAL HANDLING
PHASE I, LOWER VOID LEVEL PLAN
DR
CH
J.E.
SCALE 1"=100'
SECT MECH
CODE 404
CHF. S.E.
APP'D
CONTRACT NO. M-7545
Dravo
DRAWING NO. EM-115
REV.

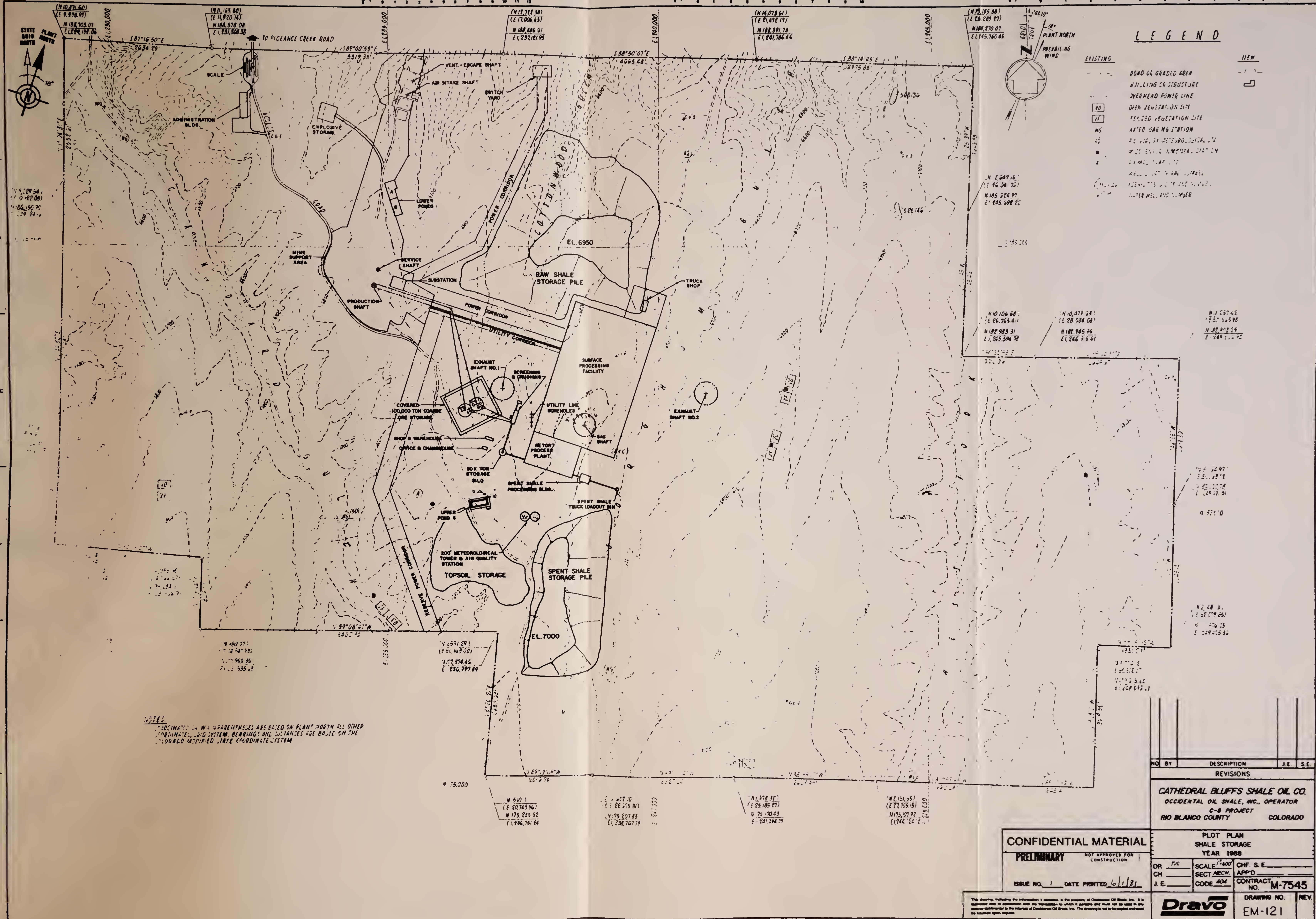


INTAKE SHAFT
EL 6705'-0
V/E SHAFT
EL 6705'-0
SERVICE SHAFT
EL 6829'-0
PRODUCTION SHAFT
EL 6829'-0
VENT. SHAFT NO 1
EL 6850'-0
VENT. SHAFT NO. 2
EL 6740'-0
GAS SHAFT
EL 6920'-0
EL 5682'-0
EL 5647'-0
EL 5545'-3
IGNITION LEVEL
EL 5476'-10
EL 5484'-10
EL 5402'-0
EL 5402'-0
UPPER VOID LEVEL
EL 5339'-8
EL 5345'-8
EL 5632'-0
EL 5635'-0
EL 5461'-0
VENT. LEVEL
EL 5464'-0
INTERMEDIATE VOID LEVEL
EL 5247'-0
EL 5210'-6
EL 5212'-6
EL 5279'-8
EL 5136'-0
EL 5136'-0
LOWER VOID LEVEL
EL 5186'-0
GAS LEVEL
EL 5124'-0
EL 5076.5
EL 5008'-0
EL 4987'-5
NO
BY
DESCRIPTION
J.E.
S.E.
REVISIONS
CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY
COLORADO
CONFIDENTIAL MATERIAL
GENERAL ARRANGEMENT
VERTICAL CROSS SECTION OF SHAFTS
PRELIMINARY
NOT APPROVED FOR CONSTRUCTION
DR
CH
J. E.
SCALE 1"-100'
SECT MECH
CODE 404
CHF. S. E.
APP'D
CONTRACT NO. M-7545
ISSUE NO. 1
DATE PRINTED 1-29-81
Dravo
DRAWING NO.
EM-116
REV.

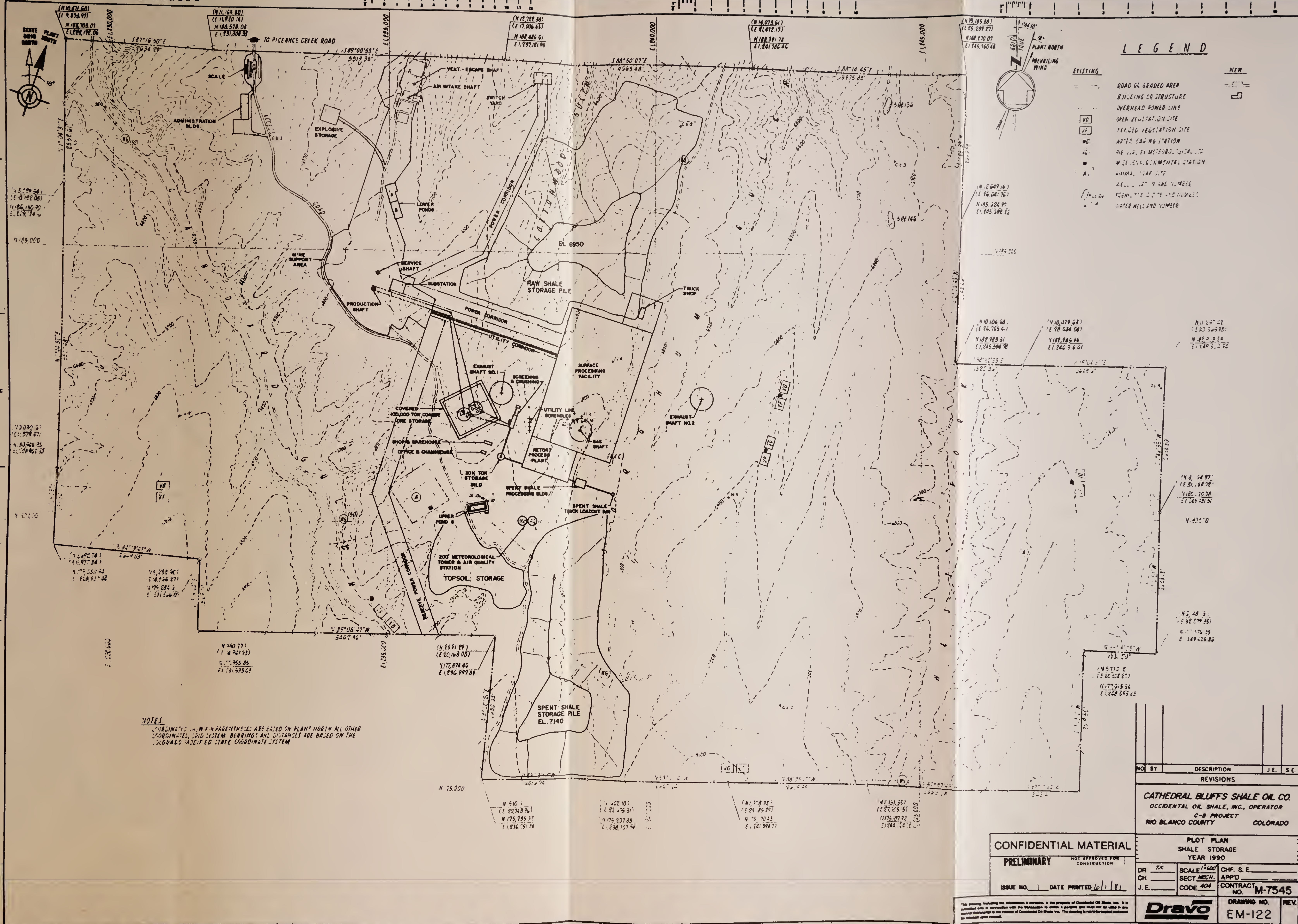

DEPTH
LITHOLOGY
ZONE
1000
1100
1200
1300
1400
1500
1600
1700
1800
UNITAH
PARACHUTE CREEK
FOUR SENATORS
"A" GROOVE
M.M.
MAHOGANY ZONE
"B" GROOVE
R-6 ZONE
L-5 ZONE
165:0 RETORT
IGNITION LEVEL
UPPER VOID LEVEL
VENT LEVEL
INTERMEDIATE VOID LEVEL
LOWER VOID LEVEL
GAS LEVEL
20:0
130:0
19:0
103:0
42:0
103:0
19:0
72:0
15:0
EXPLANATION OF SYMBOLS
SANDSTONE
SILTSTONE
MUDSTONE
LIME STONE
OIL SHALE & MAR_STONE
NO SAMPLE
TUFF BED-TUFF STRINGER OR NODULE
VUGS
SOLUTION BRECCIA ZONES OR PARTIALLY BRECCIATED INTERVAL
NAHCOLITE NODULES OR STRINGERS
FRACTURE BRECCIA (OFTEN RUBBLE)
NO
BY
DESCRIPTION
J.E.
S.E.
REVISIONS
CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY
COLORADO
CONFIDENTIAL MATERIAL
PRELIMINARY
NOT APPROVED FOR CONSTRUCTION
ISSUE NO. 1 DATE PRINTED 1-29-81
RETORT CROSS SECTION IN OIL-SHALE FORMATION
DR
CH
J.E.
SCALE 1"=30'
SECT MECH
CODE 404
CHF. S.E.
APP'D
CONTRACT NO. M-7545
Dravo
DRAWING NO.
EM-117
REV.

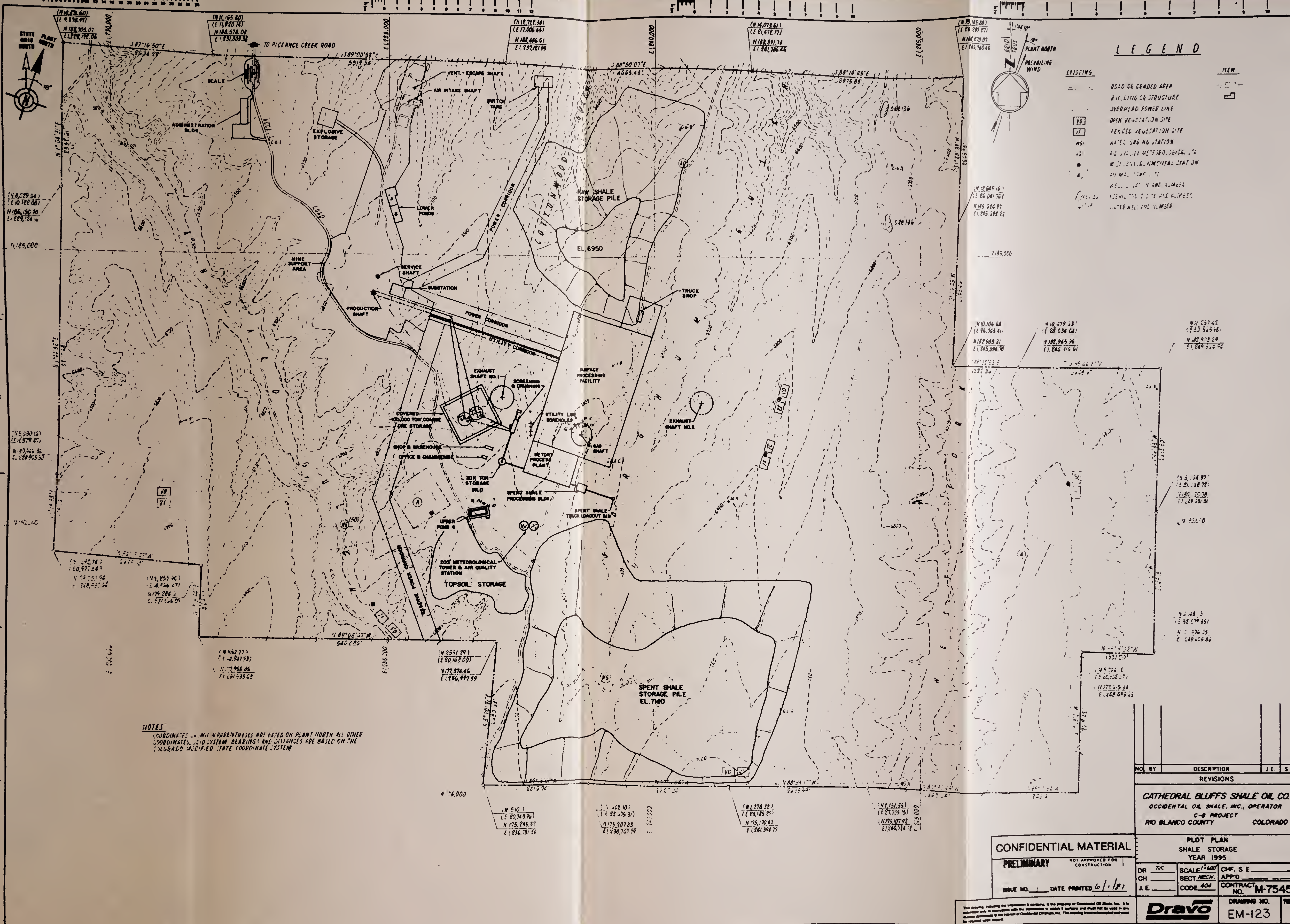

TO PICEANCE CREEK ROAD
STATE GRID NORTH
PLANT NORTH
SCALE
VENT - ESCAPE SHAFT
AIR INTAKE SHAFT
SWITCH YARD
EXPLOSIVE STORAGE
LOWER PONDS
POWER CORRIDOR
COTTONWOOD GULCH
DRAINAGE COLLECTION
T.O. PILE EL. 6860 (TYP.)
RAW SHALE STORAGE PILE
1984
1982
RUNOFF DIVERSION
TRUCK SHOP
MINE SUPPORT AREA
SERVICE SHAFT
SUBSTATION
PRODUCTION SHAFT
UTILITY CORRIDOR
EXHAUST SHAFT NO.1
SCREENING & CRUSHING
SURFACE PROCESSING FACILITY
COVERED 100,000 TON COARSE ORE STORAGE
UTILITY LINE BOREHOLES
EXHAUST SHAFT NO.2
SHOP & WAREHOUSE
OFFICE & CHANGEHOUSE
GAS SHAFT
RETORT PROCESS PLANT
30K TON STORAGE SILO
SPENT SHALE PROCESSING BLDG.
SPENT SHALE TRUCK LOADOUT BIN
UPPER POND
200' METEOROLOGICAL TOWER & AIR QUALITY STATION
TOPSOIL STORAGE
PLANT NORTH
PREVAILING WIND
LEGEND
EXISTING
ITEM
NO BY DESCRIPTION J.E. S.E.
REVISIONS
CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO
CONFIDENTIAL MATERIAL
PRELIMINARY
NOT APPROVED FOR CONSTRUCTION
ISSUE NO. 1 DATE PRINTED 6/1/81
PLOT PLAN
SHALE STORAGE
YEARS 1982 & 1984
DR TJC
CH
J.E.
SCALE 1"=600'
SECT MECH.
CODE 404
CHF. S.E.
APP'D
CONTRACT NO. M-7545
Dravo
DRAWING NO. EM-119
REV.

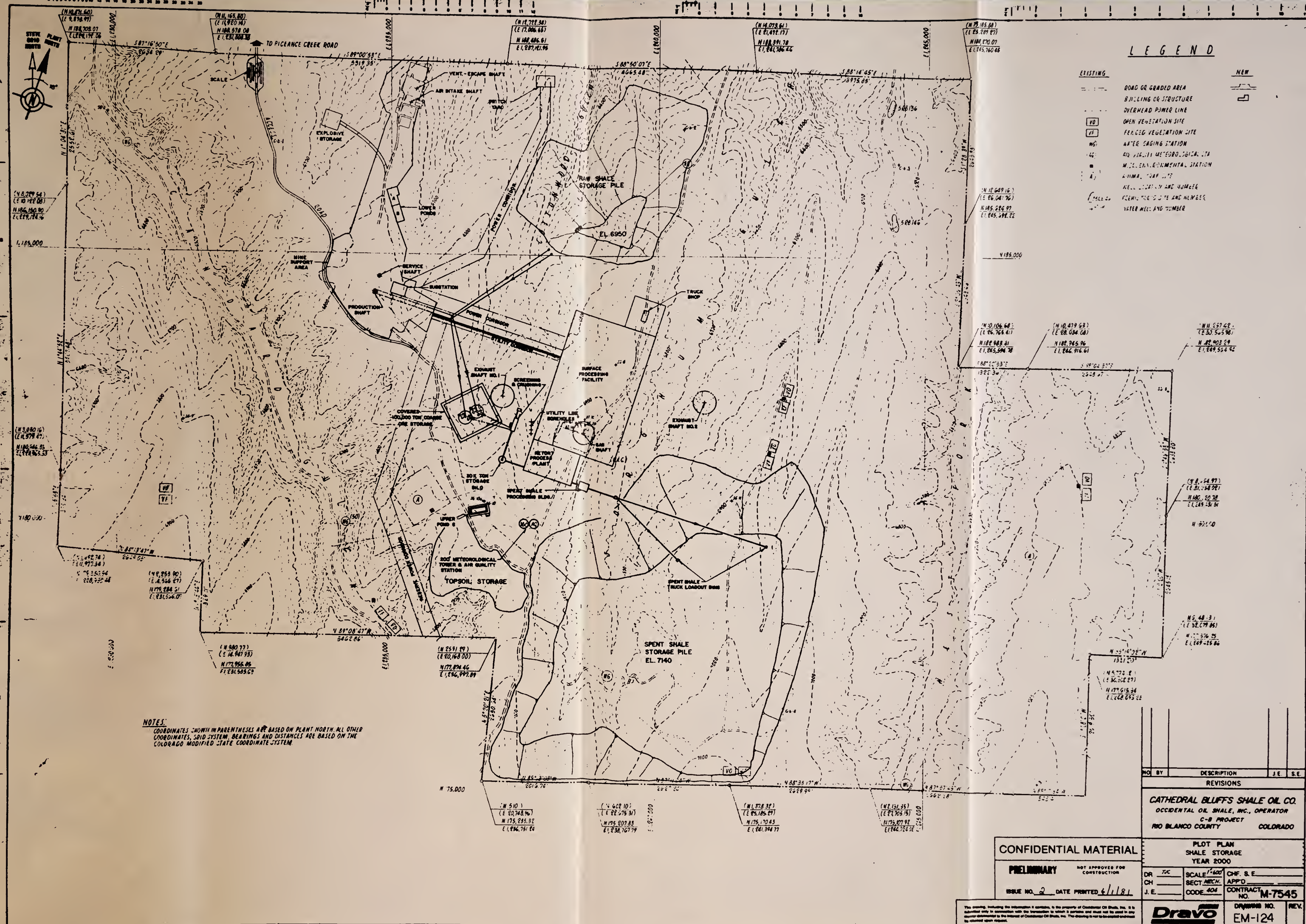

LEGEND
EXISTING
NEW
TO PICEANCE CREEK ROAD
STATE GRID NORTH
PLANT NORTH
TRUE NORTH
PREVAILING WIND
SCALE
VENT-ESCAPE SHAFT
AIR INTAKE SHAFT
SWITCH YARD
EXPLOSIVE STORAGE
LOWER PONDS
POWER CORRIDOR
COTTONWOOD GULCH
EL. 6900
RAW SHALE STORAGE PILE
MINE SUPPORT AREA
SERVICE SHAFT
SUBSTATION
PRODUCTION SHAFT
TRUCK SHOP
UTILITY CORRIDOR
SURFACE PROCESSING FACILITY
EXHAUST SHAFT NO.1
SCREENING & CRUSHING
COVERED 100,000 TON COARSE ORE STORAGE
UTILITY LINE BOREHOLES
EXHAUST SHAFT NO.2
GAS SHAFT
SHOP & WAREHOUSE
OFFICE & CHANGEHOUSE
RETORT PROCESS PLANT
30K TON STORAGE SILO
SPENT SHALE PROCESSING BLDG.
SPENT SHALE TRUCK LOADOUT BIN
UPPER POND B
EL. 7000
SPENT SHALE STORAGE PILE
200' METEOROLOGICAL TOWER & AIR QUALITY STATION
TOPSOIL STORAGE
NO. | BY | DESCRIPTION | J.E. | S.E.
REVISIONS
CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO
CONFIDENTIAL MATERIAL
PRELIMINARY
NOT APPROVED FOR CONSTRUCTION
ISSUE NO. 1 DATE PRINTED 6/1/81
PLOT PLAN
SHALE STORAGE
YEAR 1986
DR T/C
CH
J.E.
SCALE 1"=600'
SECT MECH.
CODE 404
CHF. S.E.
APP'D
CONTRACT NO. M-7545
Dravo
DRAWING NO. EM-120
REV.



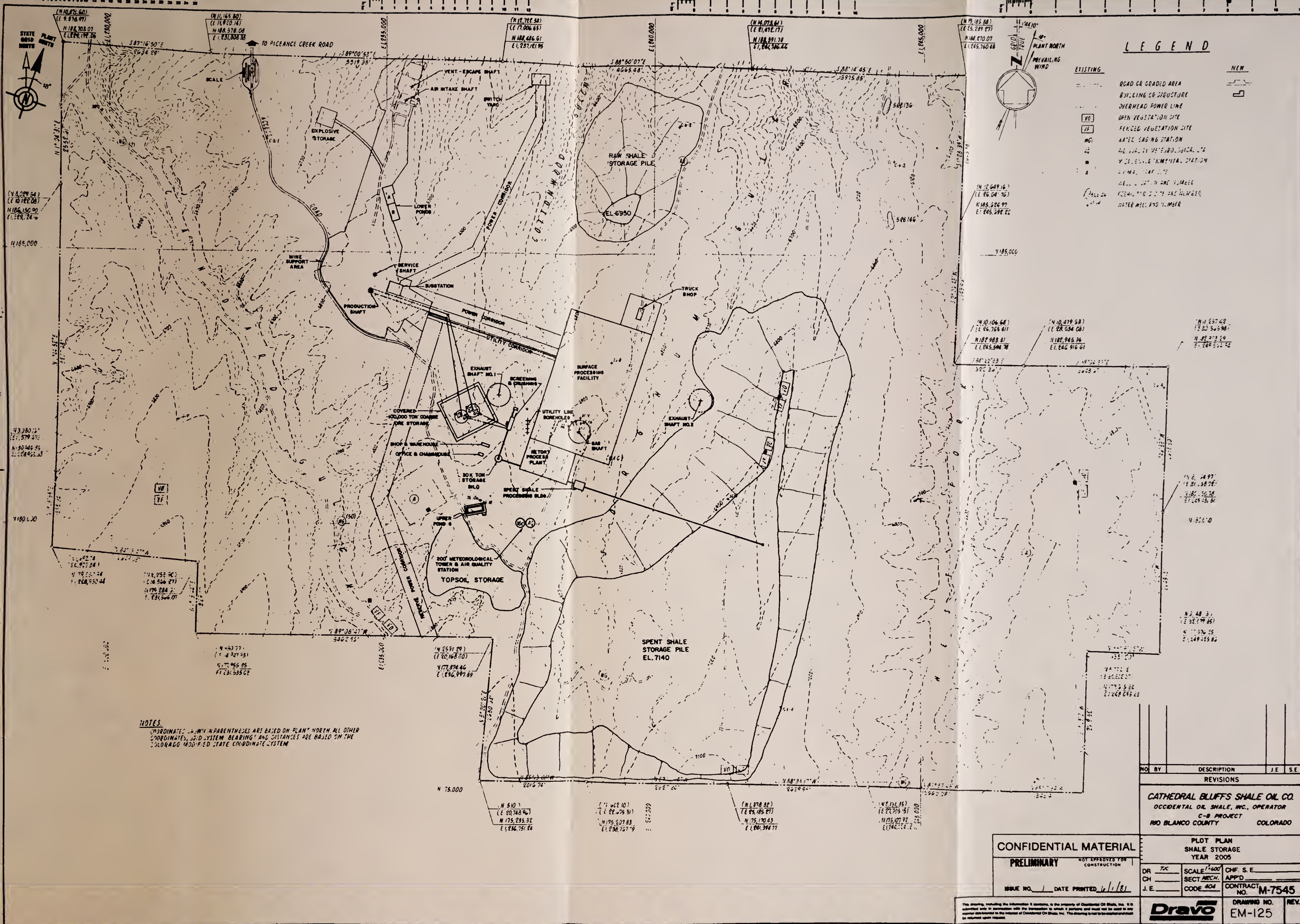
TO PICEANCE CREEK ROAD
STATE GRID NORTH
PLANT NORTH
SCALE
ADMINISTRATION BLDG.
EXPLOSIVE STORAGE
VENT-ESCAPE SHAFT
AIR INTAKE SHAFT
SWITCH YARD
LOWER PONDS
POWER CORRIDOR
ROAD
MINE SUPPORT AREA
SERVICE SHAFT
SUBSTATION
PRODUCTION SHAFT
EL. 6950
RAW SHALE STORAGE PILE
TRUCK SHOP
UTILITY CORRIDOR
SURFACE PROCESSING FACILITY
EXHAUST SHAFT NO.1
SCREENING & CRUSHING
COVERED 100,000 TON COARSE ORE STORAGE
UTILITY LINE BOREHOLES
GAS SHAFT
EXHAUST SHAFT NO.2
SHOP & WAREHOUSE
OFFICE & CHANGEHOUSE
RETORT PROCESS PLANT
30 K TON STORAGE SILO
SPENT SHALE PROCESSING BLDG.
SPENT SHALE TRUCK LOADOUT BIN
UPPER POND 6
200' METEOROLOGICAL TOWER & AIR QUALITY STATION
TOPSOIL STORAGE
SPENT SHALE STORAGE PILE
EL. 7000
POWER CORRIDOR
LEGEND
EXISTING
NEW
ROAD OR GRADED AREA
BUILDING OR STRUCTURE
OVERHEAD POWER LINE
PREVAILING WIND
NOTES:
NO. | BY | DESCRIPTION | J.E. | S.E.
REVISIONS
CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO
CONFIDENTIAL MATERIAL
PRELIMINARY
NOT APPROVED FOR CONSTRUCTION
ISSUE NO. 1 DATE PRINTED 6/1/81
PLOT PLAN
SHALE STORAGE
YEAR 1988
DR
CH
J.E.
SCALE 1"=600'
SECT MECH.
CODE 404
CHF. S.E.
APP'D
CONTRACT NO. M-7545
Dravo
DRAWING NO. EM-121
REV.

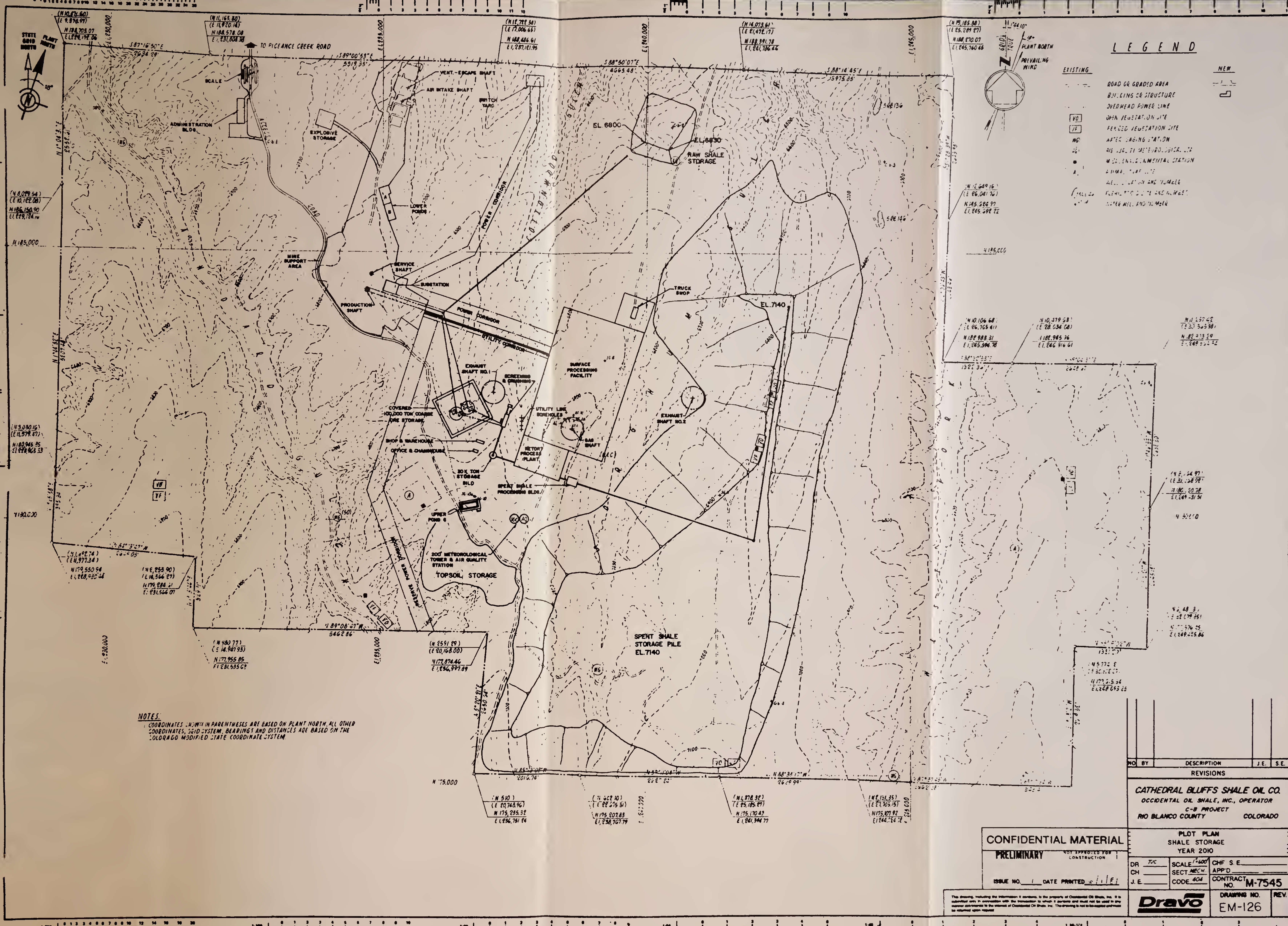

STATE GRID NORTH
PLANT NORTH
TO PICEANCE CREEK ROAD
SCALE
ADMINISTRATION BLDG.
EXPLOSIVE STORAGE
VENT.- ESCAPE SHAFT
AIR INTAKE SHAFT
SWITCH YARD
LOWER PONDS
POWER CORRIDOR
EL. 6950
RAW SHALE STORAGE PILE
TRUCK SHOP
MINE SUPPORT AREA
SERVICE SHAFT
SUBSTATION
PRODUCTION SHAFT
UTILITY CORRIDOR
EXHAUST SHAFT NO. 1
SCREENING & CRUSHING
SURFACE PROCESSING FACILITY
COVERED 100,000 TON COARSE ORE STORAGE
UTILITY LINE BOREHOLES
GAS SHAFT
EXHAUST SHAFT NO. 2
SHOPS & WAREHOUSE
OFFICE & CHANGEHOUSE
RETORT PROCESS PLANT
20 K TON STORAGE SILO
SPENT SHALE PROCESSING BLDG.
SPENT SHALE TRUCK LOADOUT BIN
UPPER POND
200' METEOROLOGICAL TOWER & AIR QUALITY STATION
TOPSOIL STORAGE
RESERVE POWER CORRIDOR
SPENT SHALE STORAGE PILE EL. 7140
PREVAILING WIND
LEGEND
EXISTING
NEW
ROAD OR GRADED AREA
BUILDING OR STRUCTURE
OVERHEAD POWER LINE
NOTES.
COORDINATES SHOWN IN PARENTHESES ARE BASED ON PLANT NORTH ALL OTHER COORDINATES, GRID SYSTEM BEARINGS AND DISTANCES ARE BASED ON THE COLORADO MODIFIED STATE COORDINATE SYSTEM
NO | BY | DESCRIPTION | J.E. | S.E.
REVISIONS
CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO
CONFIDENTIAL MATERIAL
PRELIMINARY
NOT APPROVED FOR CONSTRUCTION
ISSUE NO. 1 DATE PRINTED 6/1/81
PLOT PLAN
SHALE STORAGE
YEAR 1990
DR T.K.
CH
J.E.
SCALE 1"=600'
SECT. MECH.
CODE 404
CHF. S.E.
APP'D
CONTRACT NO. M-7545
Dravo
DRAWING NO.
EM-122
REV.


TO PICEANCE CREEK ROAD
STATE GRID NORTH
PLANT NORTH
SCALE
ADMINISTRATION BLDG.
EXPLOSIVE STORAGE
VENT-ESCAPE SHAFT
AIR INTAKE SHAFT
SWITCH YARD
LOWER PONDS
POWER CORRIDOR
RAW SHALE STORAGE PILE
EL. 6950
MINE SUPPORT AREA
SERVICE SHAFT
SUBSTATION
PRODUCTION SHAFT
TRUCK SHOP
UTILITY CORRIDOR
SURFACE PROCESSING FACILITY
EXHAUST SHAFT NO.1
SCREENING & CRUSHING
COVERED 100,000 TON COARSE ORE STORAGE
UTILITY LINE BOREHOLES
EXHAUST SHAFT NO.2
SHOP & WAREHOUSE
OFFICE & CHANGEHOUSE
GAS SHAFT
RETORT PROCESS PLANT
30K TON STORAGE SILO
SPENT SHALE PROCESSING BLDG.
SPENT SHALE TRUCK LOADOUT BIN
UPPER POND
200' METEOROLOGICAL TOWER & AIR QUALITY STATION
TOPSOIL STORAGE
SPENT SHALE STORAGE PILE EL. 7190
PREVAILING WIND
LEGEND
EXISTING
NEW
NOTES
CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY
COLORADO
PLOT PLAN
SHALE STORAGE
YEAR 1995
NO
BY
DESCRIPTION
J.E.
S.E.
REVISIONS
CONFIDENTIAL MATERIAL
PRELIMINARY
NOT APPROVED FOR CONSTRUCTION
ISSUE NO. 1 DATE PRINTED 6/1/81
DR T/C
CH
J.E.
SCALE 1"=600'
SECT MECH.
CODE 404
CHF. S.E.
APP'D
CONTRACT NO. M-7545
Dravo
DRAWING NO.
EM-123
REV.

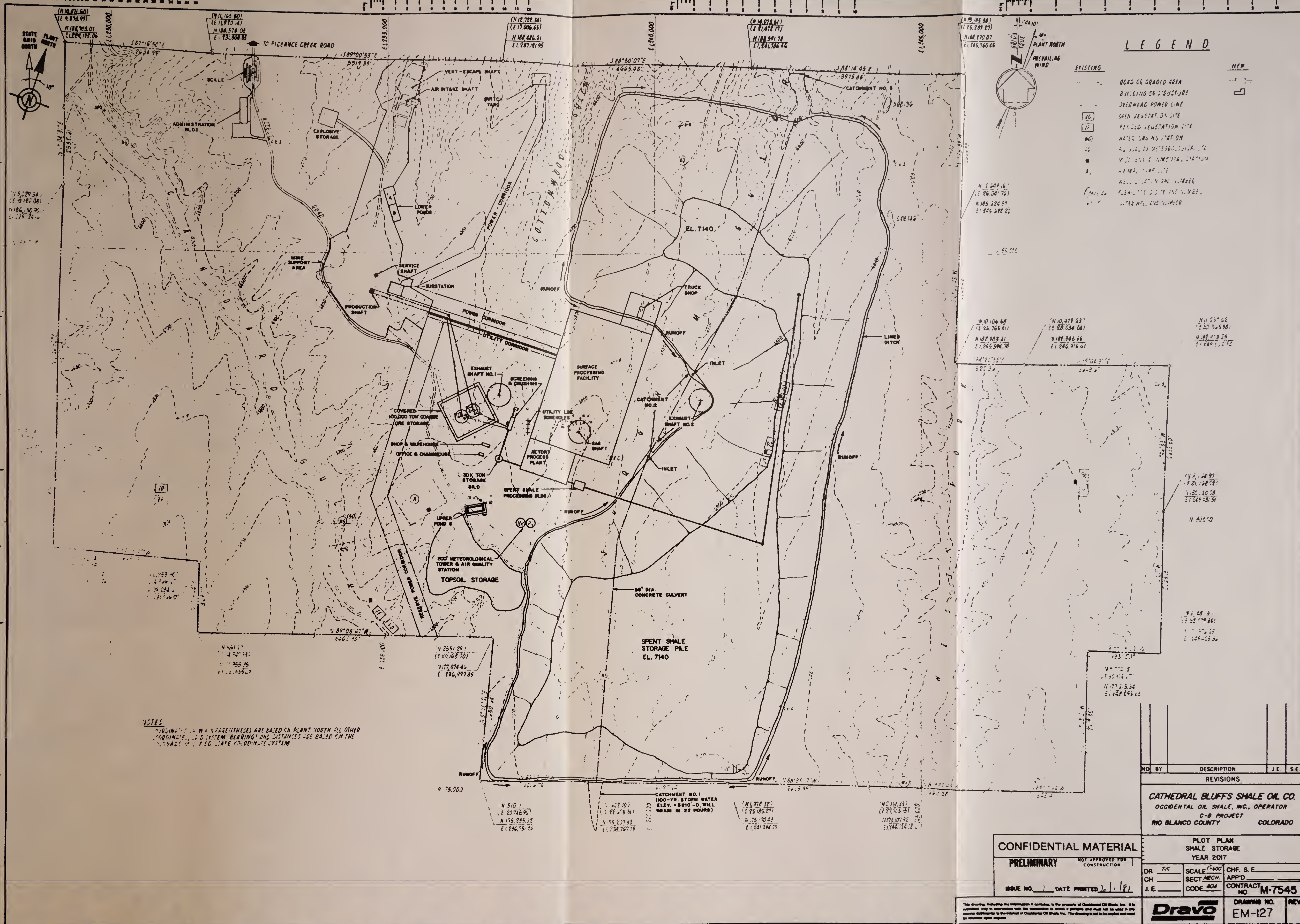


LEGEND
EXISTING
NEW
ROAD OR GRADED AREA
BUILDING OR STRUCTURE
OVERHEAD POWER LINE
OPEN VEGETATION SITE
FENCED VEGETATION SITE
WATER GAGING STATION
WATER WELL AND NUMBER
TO PICEANCE CREEK ROAD
SCALE
VENT - ESCAPE SHAFT
AIR INTAKE SHAFT
SWITCH YARD
EXPLOSIVE STORAGE
LOWER PONDS
RAW SHALE STORAGE PILE
EL. 6950
MINE SUPPORT AREA
SERVICE SHAFT
SUBSTATION
PRODUCTION SHAFT
POWER CORRIDOR
UTILITY CORRIDOR
TRUCK SHOP
EXHAUST SHAFT NO. 1
SCREENING & CRUSHING
SURFACE PROCESSING FACILITY
COVERED 100,000 TON COARSE ORE STORAGE
UTILITY LINE BOREHOLES
EXHAUST SHAFT NO. 2
GAS SHAFT
RETORT PROCESS PLANT
30K TON STORAGE SILO
SPENT SHALE PROCESSING BLDG.
UPPER POND
300' METEOROLOGICAL TOWER & AIR QUALITY STATION
TOPSOIL STORAGE
SPENT SHALE TRUCK LOADOUT BINS
SPENT SHALE STORAGE PILE
EL. 7140
NOTES:
COORDINATES SHOWN IN PARENTHESES ARE BASED ON PLANT NORTH. ALL OTHER COORDINATES, GRID SYSTEM, BEARINGS AND DISTANCES ARE BASED ON THE COLORADO MODIFIED STATE COORDINATE SYSTEM.
NO | BY | DESCRIPTION | J.E. | S.E.
REVISIONS
CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO
CONFIDENTIAL MATERIAL
PRELIMINARY
NOT APPROVED FOR CONSTRUCTION
ISSUE NO. 2 DATE PRINTED 6/1/81
PLOT PLAN
SHALE STORAGE
YEAR 2000
DR TJC
CH
J.E.
SCALE 1"=600'
SECT. MECH.
CODE 404
CHF. S.E.
APP'D
CONTRACT NO. M-7545
Dravo
DRAWING NO. EM-124
REV.

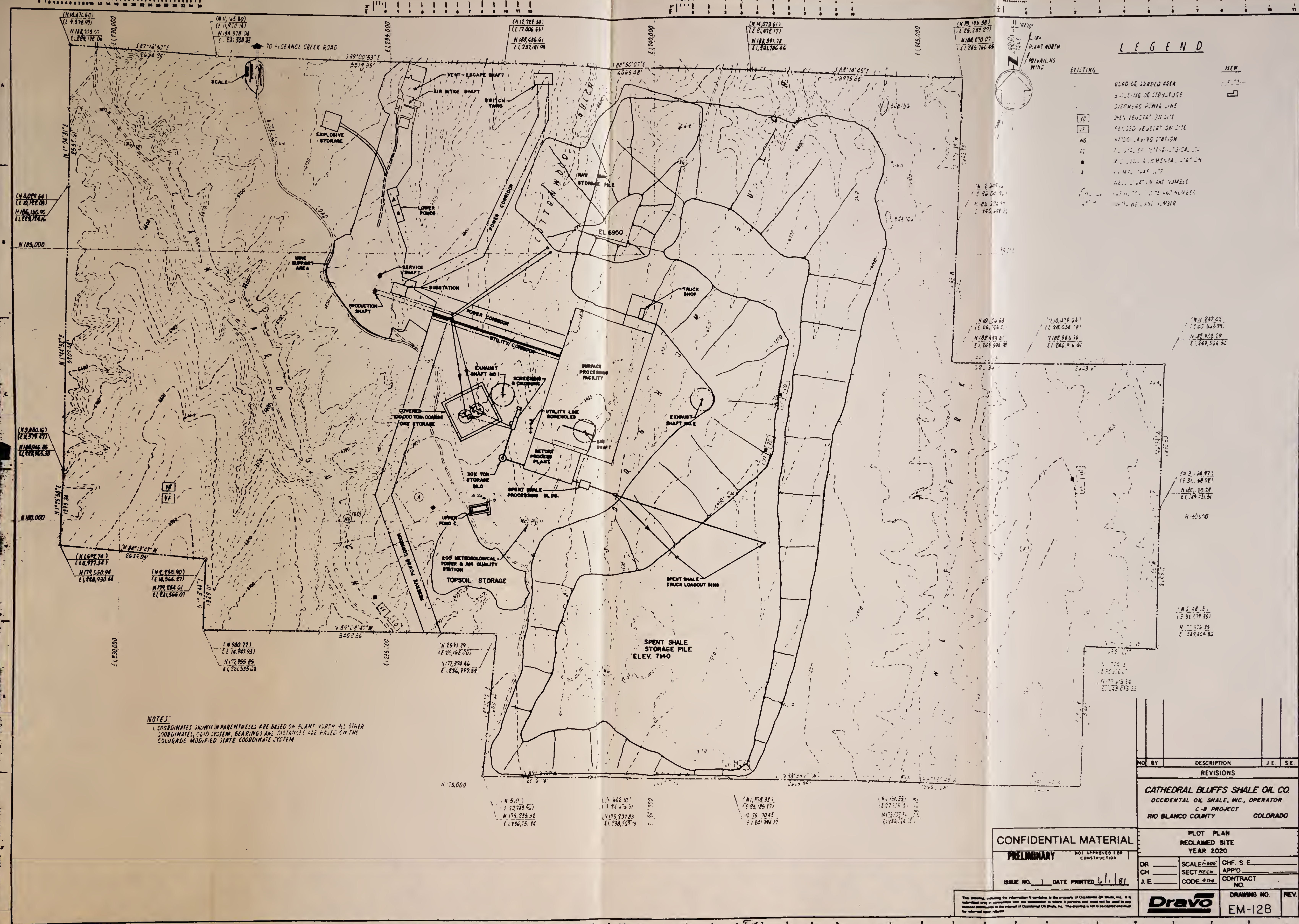

TO PICEANCE CREEK ROAD
SCALE
VENT - ESCAPE SHAFT
AIR INTAKE SHAFT
SWITCH YARD
EXPLOSIVE STORAGE
RAW SHALE STORAGE PILE
EL. 6950
LOWER PONDS
POWER CORRIDOR
COTTONWOOD GULCH
ROAD
MINE SUPPORT AREA
SERVICE SHAFT
SUBSTATION
PRODUCTION SHAFT
POWER CORRIDOR
UTILITY CORRIDOR
TRUCK SHOP
SURFACE PROCESSING FACILITY
EXHAUST SHAFT NO. 1
SCREENING & CRUSHING
COVERED 100,000 TON COARSE ORE STORAGE
UTILITY LINE BOREHOLES
EXHAUST SHAFT NO. 2
SHOP & WAREHOUSE
OFFICE & CHANGEHOUSE
RETORT PROCESS PLANT
GAS SHAFT
30K TON STORAGE SILO
SPENT SHALE PROCESSING BLDG.
UPPER POND
200' METEOROLOGICAL TOWER & AIR QUALITY STATION
TOPSOIL STORAGE
SPENT SHALE STORAGE PILE
EL. 7140
LEGEND
EXISTING
NEW
ROAD OR GRADED AREA
BUILDING OR STRUCTURE
OVERHEAD POWER LINE
OPEN VEGETATION SITE
FENCED VEGETATION SITE
WATER GAGING STATION
PLANT NORTH
PREVAILING WIND
NOTES.
COORDINATES SHOWN IN PARENTHESES ARE BASED ON PLANT NORTH. ALL OTHER COORDINATES, GRID SYSTEM BEARINGS AND DISTANCES ARE BASED ON THE COLORADO MODIFIED STATE COORDINATE SYSTEM
NO | BY | DESCRIPTION | J.E | S.E.
REVISIONS
CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO
CONFIDENTIAL MATERIAL
PRELIMINARY
NOT APPROVED FOR CONSTRUCTION
ISSUE NO. 1 DATE PRINTED 6/1/81
PLOT PLAN
SHALE STORAGE
YEAR 2005
DR TJC
CH
J. E.
SCALE 1"=600'
SECT MECH.
CODE 404
CHF. S. E.
APP'D
CONTRACT NO. M-7545
Dravo
DRAWING NO.
EM-125
REV.

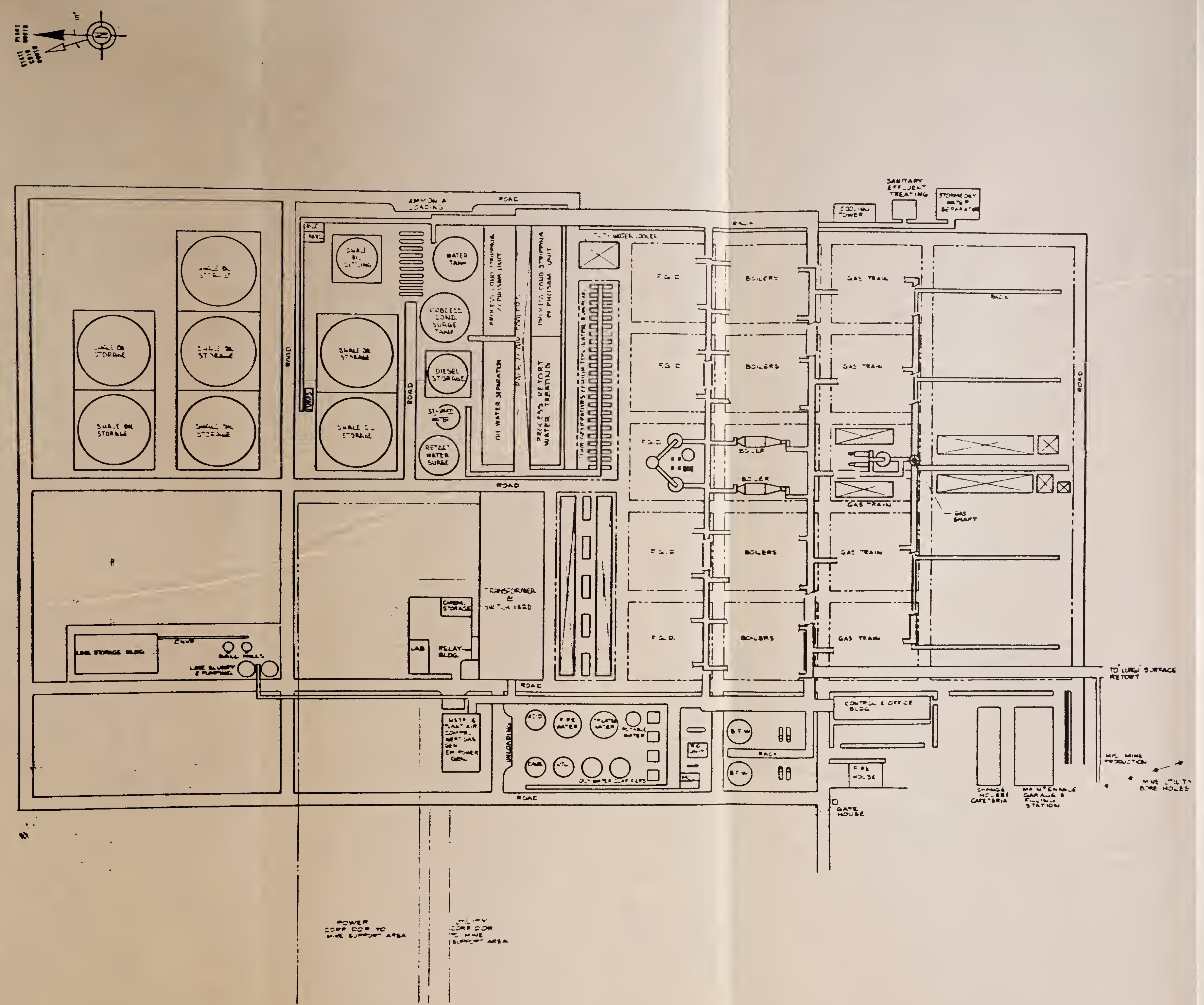


TO PICEANCE CREEK ROAD
SCALE
ADMINISTRATION BLDG.
EXPLOSIVE STORAGE
VENT.-ESCAPE SHAFT
AIR INTAKE SHAFT
SWITCH YARD
EL 6800
EL.6830
RAW SHALE STORAGE
LOWER PONDS
POWER CORRIDOR
MINE SUPPORT AREA
SERVICE SHAFT
SUBSTATION
PRODUCTION SHAFT
UTILITY CORRIDOR
TRUCK SHOP
EL.7140
SURFACE PROCESSING FACILITY
EXHAUST SHAFT NO.1
SCREENING & CRUSHING
COVERED 100,000 TON COARSE ORE STORAGE
UTILITY LINE BOREHOLES
EXHAUST SHAFT NO.2
SHOP & WAREHOUSE
OFFICE & CHANGEHOUSE
GAS SHAFT
RETORT PROCESS PLANT
30K TON STORAGE BLD
SPENT SHALE PROCESSING BLDG.
UPPER POND 6
2017 METEOROLOGICAL TOWER & AIR QUALITY STATION
TOPSOIL STORAGE
SPENT SHALE STORAGE PILE EL.7140
N 185,000
N 180,000
N 175,000
E 1,930,000
E 1,935,000
E 1,940,000
E 1,945,000
PLANT NORTH
PREVAILING WIND
LEGEND
EXISTING
NEW
ROAD OR GRADED AREA
BUILDING OR STRUCTURE
OVERHEAD POWER LINE
OPEN VEGETATION SITE
FENCED VEGETATION SITE
NOTES.
COORDINATES SHOWN IN PARENTHESES ARE BASED ON PLANT NORTH. ALL OTHER COORDINATES, GRID SYSTEM, BEARINGS AND DISTANCES ARE BASED ON THE COLORADO MODIFIED STATE COORDINATE SYSTEM.
NO. BY DESCRIPTION J.E. S.E.
REVISIONS
CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO
CONFIDENTIAL MATERIAL
PRELIMINARY
NOT APPROVED FOR CONSTRUCTION
PLOT PLAN
SHALE STORAGE
YEAR 2010
SCALE 1"=600'
CONTRACT NO. M-7545
Dravo
DRAWING NO.
REV.
EM-126



LEGEND
EXISTING
NEW
TO PICEANCE CREEK ROAD
VENT - ESCAPE SHAFT
AIR INTAKE SHAFT
SWITCH YARD
ADMINISTRATION BLDG
EXPLOSIVE STORAGE
LOWER PONDS
POWER CORRIDOR
COTTONWOOD GULCH
EL. 7140
MINE SUPPORT AREA
SERVICE SHAFT
SUBSTATION
PRODUCTION SHAFT
UTILITY CORRIDOR
RUNOFF
TRUCK SHOP
LINED DITCH
SURFACE PROCESSING FACILITY
INLET
EXHAUST SHAFT NO. 1
SCREENING & CRUSHING
COVERED 100,000 TON COARSE ORE STORAGE
UTILITY LINE BOREHOLES
CATCHMENT NO. 2
EXHAUST SHAFT NO. 2
SHOP & WAREHOUSE
OFFICE & CHANGEHOUSE
GAS SHAFT
RETORT PROCESS PLANT
30K TON STORAGE SILO
SPENT SHALE PROCESSING BLDG.
UPPER POND
200' METEOROLOGICAL TOWER & AIR QUALITY STATION
TOPSOIL STORAGE
36" DIA. CONCRETE CULVERT
SPENT SHALE STORAGE PILE EL. 7140
CATCHMENT NO. 1 (100-YR. STORM WATER ELEV. = 8010'-0, WILL DRAIN IN 22 HOURS)
NOTES
NO | BY | DESCRIPTION | J.E. | S.E.
REVISIONS
CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO
CONFIDENTIAL MATERIAL
PRELIMINARY
NOT APPROVED FOR CONSTRUCTION
ISSUE NO. 1 DATE PRINTED 2/1/81
PLOT PLAN
SHALE STORAGE
YEAR 2017
DR T/C
CH
J. E.
SCALE 1"=600'
SECT MECH.
CODE 404
CHF. S. E.
APP'D
CONTRACT NO. M-7545
Dravo
DRAWING NO.
EM-127
REV.


TO PICEANCE CREEK ROAD
SCALE
VENT-ESCAPE SHAFT
AIR INTAKE SHAFT
SWITCH YARD
EXPLOSIVE STORAGE
LOWER PONDS
POWER CORRIDOR
RAW SHALE STORAGE PILE
EL. 6950
MINE SUPPORT AREA
SERVICE SHAFT
SUBSTATION
PRODUCTION SHAFT
POWER CORRIDOR
UTILITY CORRIDOR
TRUCK SHOP
SURFACE PROCESSING FACILITY
EXHAUST SHAFT NO.1
SCREENING & CRUSHING
COVERED 100,000 TON COARSE ORE STORAGE
UTILITY LINE BOREHOLES
EXHAUST SHAFT NO.2
V/S SHAFT
RETORT PROCESS PLANT
30K TON STORAGE SILO
SPENT SHALE PROCESSING BLDG.
UPPER POND C
200' METEOROLOGICAL TOWER & AIR QUALITY STATION
TOPSOIL STORAGE
SPENT SHALE TRUCK LOADOUT BINS
SPENT SHALE STORAGE PILE ELEV. 7140
N 185,000
N 180,000
N 175,000
E 2,230,000
E 2,235,000
E 2,240,000
E 2,245,000
PLANT NORTH
PREVAILING WIND
LEGEND
EXISTING
NEW
NOTES:
1. COORDINATES SHOWN IN PARENTHESES ARE BASED ON PLANT NORTH. ALL OTHER COORDINATES, GRID SYSTEM, BEARINGS AND DISTANCES ARE BASED ON THE COLORADO MODIFIED STATE COORDINATE SYSTEM
NO BY DESCRIPTION J.E. S.E.
REVISIONS
CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO
CONFIDENTIAL MATERIAL
PRELIMINARY
NOT APPROVED FOR CONSTRUCTION
ISSUE NO. 1 DATE PRINTED 6/1/81
PLOT PLAN
RECLAIMED SITE
YEAR 2020
DR
CH
J.E.
SCALE 1:600'
SECT MECH
CODE 404
CHF. S.E.
APP'D
CONTRACT NO.
Dravo
DRAWING NO.
EM-128
REV.



NO.	BY	DESCRIPTION		

REVISIONS

CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO

CONFIDENTIAL MATERIAL

GENERAL ARRANGEMENT
SURFACE PROCESSING FACILITY
PLAN

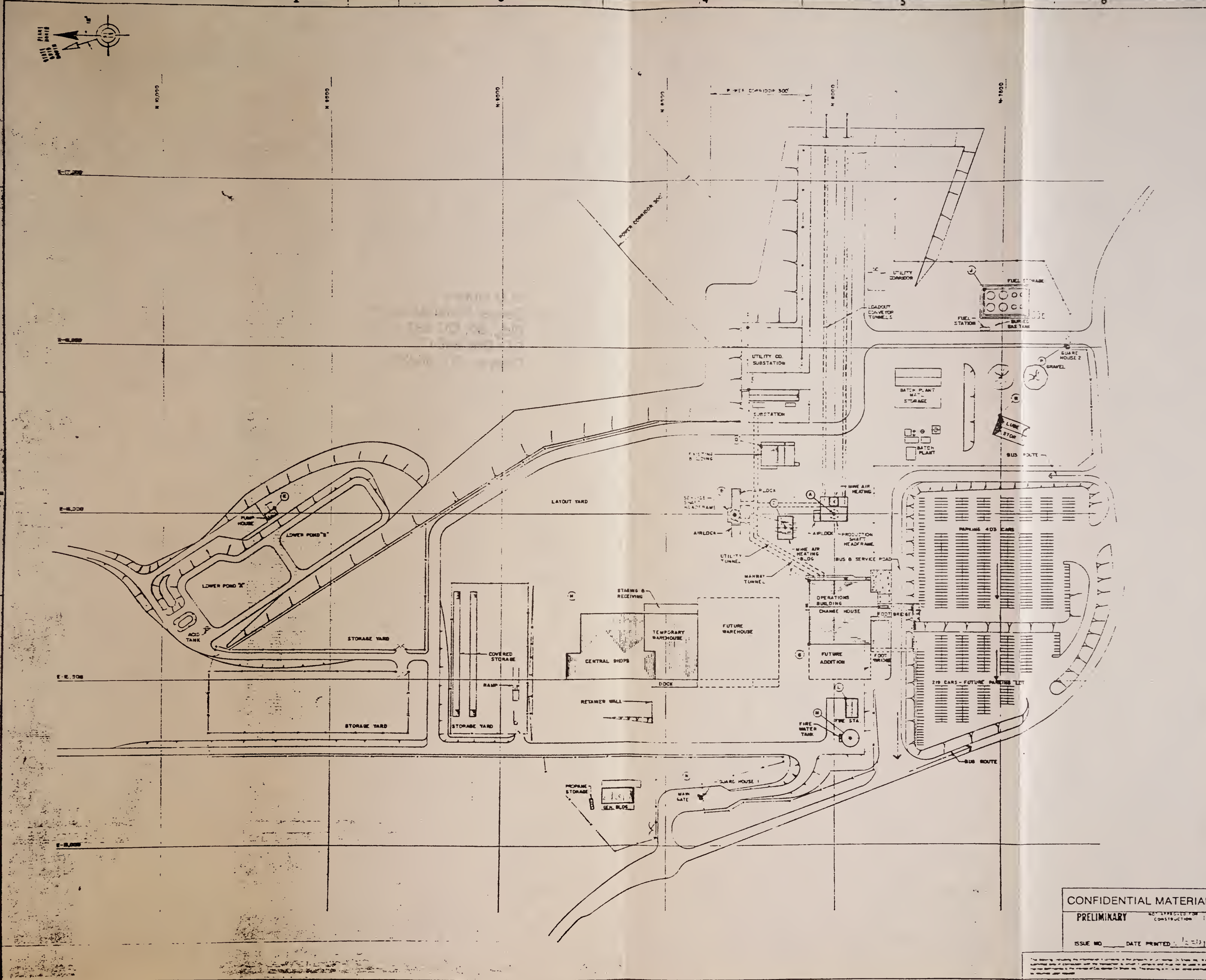
DR. ____ SCALE ____ CHF. S.E. ____
CH. ____ SECT. ____ APP'D ____
E ____ CODE ____ CONTRACT NO. N-7545

ISSUE NO. ____ DATE PRINTED ____

Dravo

DRAWING NO. EM-13C

REV



	DESCRIPTION	COORDINATES
A	PRODUCTION SHAFT ℄	[illegible]
B	SERVICE SHAFT ℄	[illegible]
C	AIR TUNNEL ℄	[illegible]
D	SUBSTATION N-E CORNER	[illegible]
E	SUBSTATION BLDG	[illegible]
F	OPERATIONS BUILDING	[illegible]
G	CHANGE HOUSE	[illegible]
H	WAREHOUSE & SHOP	[illegible]
J	FUEL STORAGE	[illegible]
K	PUMP HOUSE	
L	FIRE STATION	[illegible]
M	FIRE WATER TANK	[illegible]
N	GUARD HOUSE 1	[illegible]
P	GUARD HOUSE 2	[illegible]
Q	EXISTING BUILDING	[illegible]
R	LUBE STORAGE	N - 7506.13 E - 4294.98

NO	BY	DESCRIPTION		

REVISIONS

CATHEDRAL BLUFFS SHALE OIL CO.
OCCIDENTAL OIL SHALE, INC., OPERATOR
C-B PROJECT
RIO BLANCO COUNTY COLORADO

CONFIDENTIAL MATERIAL

PRELIMINARY — NOT APPROVED FOR CONSTRUCTION

ISSUE NO ____ DATE PRINTED ____

GENERAL ARRANGEMENT
MINE SUPPORT FACILITIES
PLOT PLAN

DR T/C
CH
J E
SCALE 1"=100'
SECT MECH.
CODE
CHF S E
APP'D
CONTRACT NO M-7545

Dravo

DRAWING NO EM-131
REV